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THE MAGAZINE OF WORLD SULPHUR

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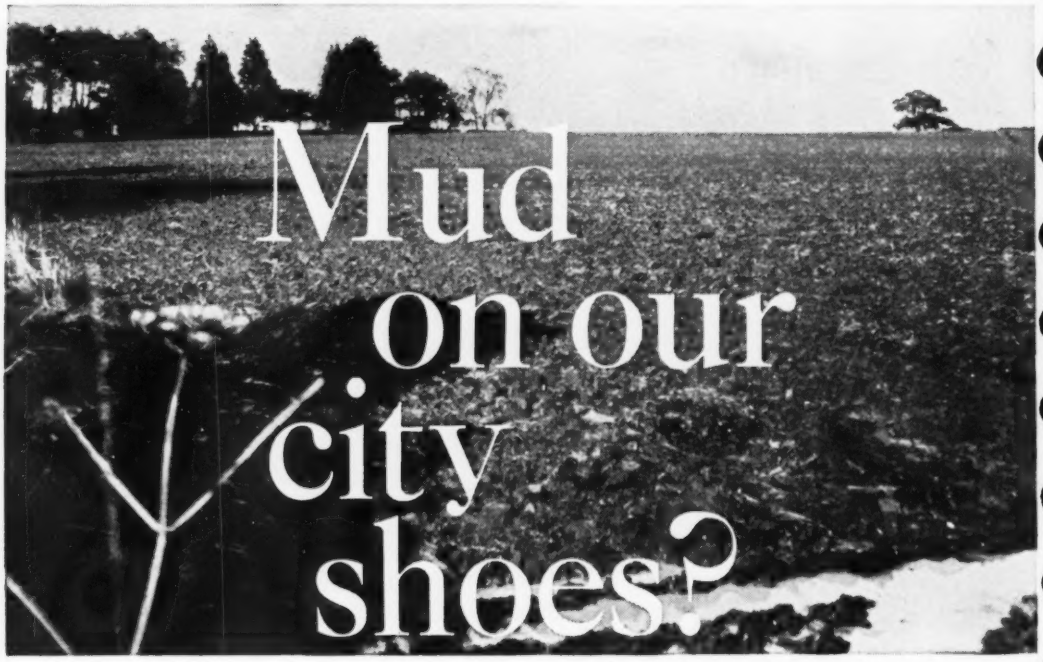

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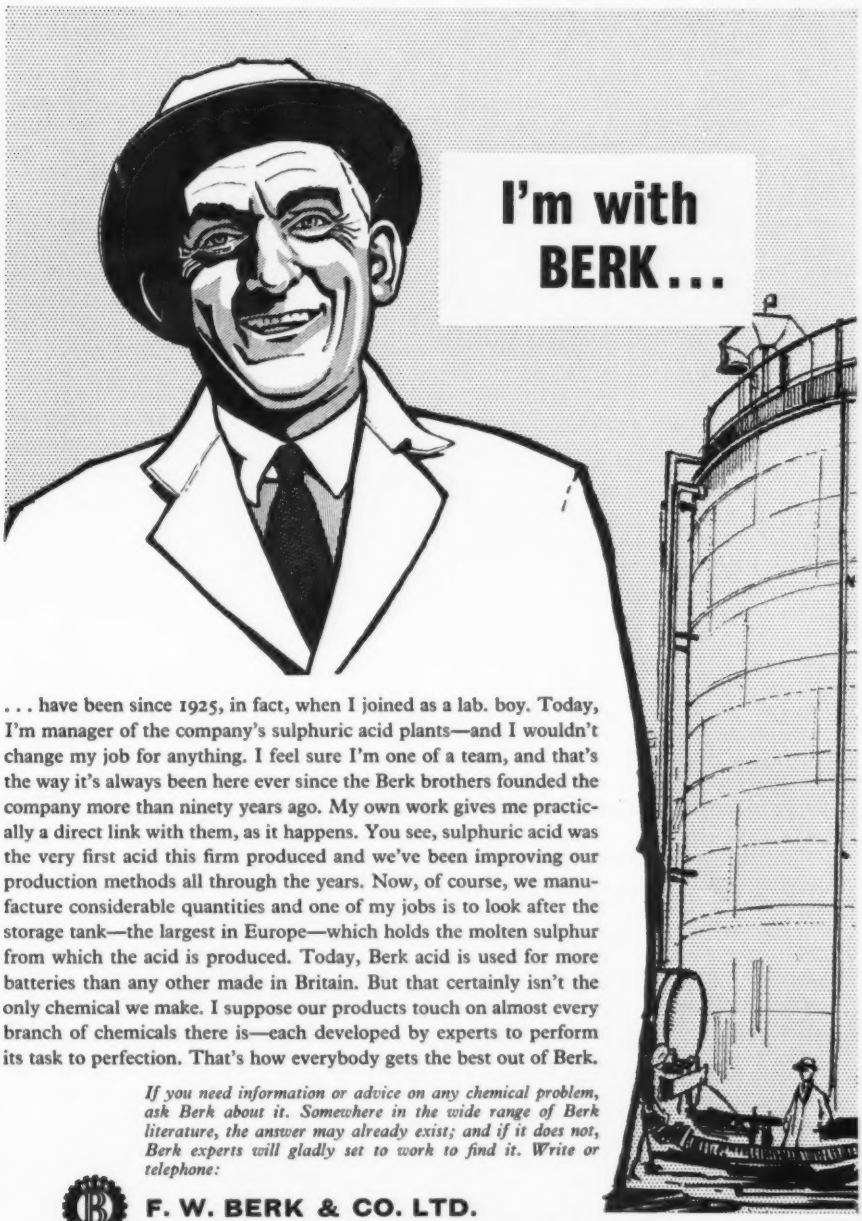

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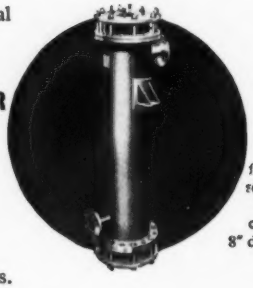

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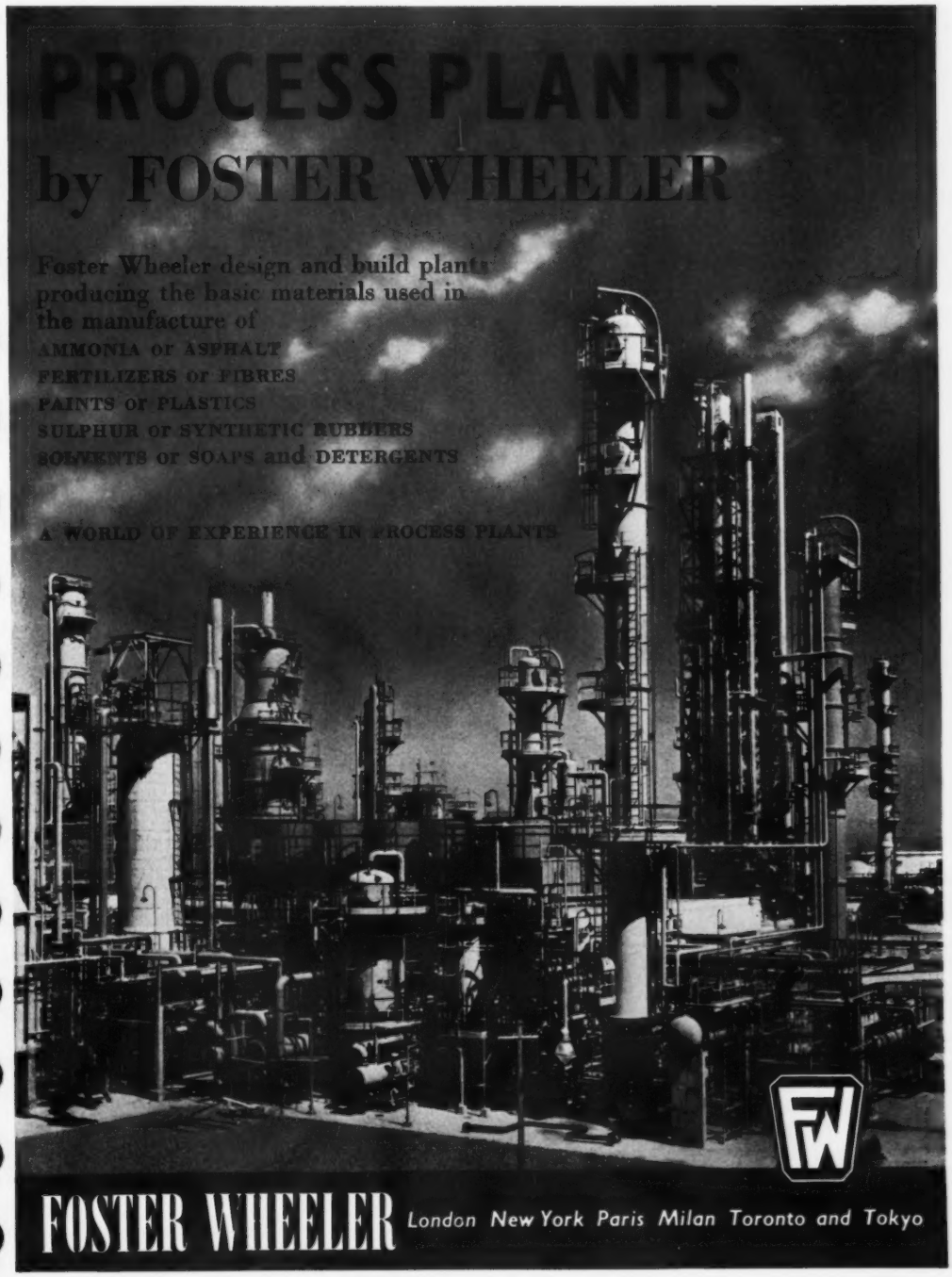
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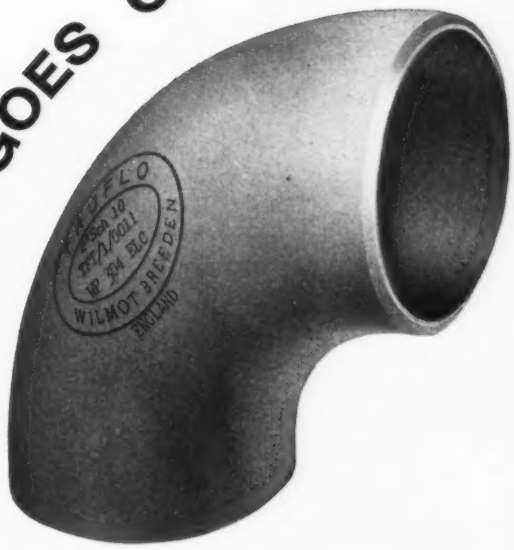

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Twelve Largest Sulphuric Acid Producing Countries

('000 tonnes 100% H_2SO_4)

	1950	1955	1959	1960
United States	11,016	13,897	15,258	15,445
U.S.S.R.	2,125	3,798	5,100	5,400
Japan	2,031	3,290	4,195	4,452
West Germany	1,416	2,279	2,938	3,174
United Kingdom	1,832	2,131	2,468	2,745
France	1,218	1,473	1,826	1,983
Italy	1,276	1,943	2,044	2,065
Canada	686	862	1,461	1,499
Belgium	880	1,143	1,227	1,404
Spain	507	853	1,173	1,057
Australia	650	910	1,017	1,127
China	49	375	1,060	1,300*

* Provisional

The high level of sulphuric acid output in 1960 reflects the strong demand for sulphuric acid supplies from world fertilizer industry.

Communist Countries

Production and use of sulphuric acid in the U.S.S.R. grew 6% in 1960 to 5.4 million tonnes (100% H_2SO_4), substantially less than the earlier 1960 target of 7 million tonnes. Strong demand by the fertilizer, plastics, steel, textile and detergent industries in Eastern Europe raised production by 13% to 2.6 million tonnes. Especially in East Germany and Poland output is rising rapidly and both countries are likely to produce in excess of one million tonnes a year within the next three years. Production in China in 1960 is estimated to have risen to 1.3 million tonnes.

Western Europe

In Western Europe sulphuric acid production and use rose 6% over 1959. Strong demand for ammonium sulphate and phosphoric acid, in particular for triple superphosphate and ammonium phosphate, has coincided with the increasing requirements of other large acid-using industries, notably titanium oxide, viscose rayon, plastics and detergents and chemicals.

The largest quantitative increases occurred in the U.K. (+11.3%), Western Germany (+8%) and Belgium (+14.1%).

The rising demand for chemicals by Finland's sulphite pulp industry contributed to increased sulphuric acid requirements, which rose 11.2% (21,000 tonnes). Fertilizer production with its concomitant call on sulphuric acid in the Netherlands has strongly advanced in the last five years and preliminary figures for 1960 show that sulphuric acid production has continued to rise—4.3% higher than in 1959 and about 90% greater than in 1950.

Production in Spain declined (−9.8%) due to reduced fertilizer activity in first half of 1960.

North America

In the 10-year period 1950 to 1959, Canada's production of sulphuric acid more than doubled, reaching the high level of 1,461,000 tonnes in 1959. Last year's production remained buoyant at 1,499,000 tonnes, despite the reduced demand of the Canadian uranium industry.

In the U.S.A. sulphuric acid production showed a slight increase (+1.2%) and although the industry operated at only about 75% of capacity in 1960, supply was in excess of demand. The low level of the steel industry's operations partly due to the recession in the U.S. car industry, adversely affected demand, especially in the manufacture of by-product ammonium sulphate. Titanium dioxide, rayon manufacture and oil refining also receded, and only greater demand for sulphuric acid by the fertilizer industry, notably in the manufacture of wet phosphoric acid, the plastics and synthetic fibres sectors, and for general chemicals, redressed the balance.

Central and South America

Expanding industrial development including greater requirements for fertilizer manufacture caused a substantial increase in sulphuric acid production; compared with 1959, it rose by 12% to 969,000 tonnes.

Asia

Japan's vast industry overshadows the sulphuric acid picture in Asia, where total production and use rose about 332,000 tonnes (6.8%) in 1960 to 5,212,000 tonnes. Japan's sulphuric acid production has continued to increase—6% in 1960—reflecting the developments of phosphatic fertilizers, man-made and

synthetic fibres, steel and also Japan's detergent industry, which is making rapid strides. Excluding Japan, production rose 11% mainly on account of the substantial growth in India, where production is estimated to have risen in 1960 by 17.2% to about 320,000 tonnes.

Africa

Total sulphuric acid production in Africa in 1960 rose by 4.5%. Greater fertilizer activity in Egypt has increased sulphuric acid requirements by an estimated 20,000 tonnes a year and in South Africa and Southern Rhodesia acid demand for fertilizers also rose.

Australia and New Zealand

With the exception of minor setbacks, demand for sulphuric acid in Australia has been increasing steadily in recent years, and Australia is now the twelfth largest producer in the world. Superphosphate manufacture, the largest user of acid, expanded in contrast to the small ammonium sulphate sector. Fertilizer still accounts for 80% of acid consumption, but industrial requirements, notably man-made and synthetic textiles, pigments and chemicals, are growing rapidly. In New Zealand the start of operations of new superphosphate plants boosted sulphuric acid production by 14%.

Finland's Expanding Sulphuric Acid Use

NEW plant with a production capacity of 70,000 tons of sodium sulphate is to be built by the Finnish state sulphuric acid and superphosphate enterprise. Rikkihappo Ja Superfosfaatitehaat Oy, of Helsinki, at its works at Kokkola, where installed capacity, based on domestic pyrites, is 42,000 tons (100% H_2SO_4) used at present principally for superphosphate production. An expansion of the acid plant capacity is under consideration.

Dependence on Imports

With the exception of the output from the small plant at Valkeakoski of Sateri Oy, a viscose rayon producer, Finland has so far been wholly dependent on imports for her sodium sulphate needs. Project engineering and design of the new sodium sulphate plant will be carried out by Zahn and Company, G.m.b.H., Berlin. Sodium sulphate will be produced in 10 mechanical saltcake furnaces, each with a diameter of 6 metres. Raw materials will be pretreated, automatically metered and fed to the plant.

Aluminium Sulphate

Also under construction at the present time by Rikkihappo is a 30,000 ton a year aluminium sulphate plant at Harjavalta. The output from the new plant which will process imported aluminium oxide will be used for water purification, principally for the pulp industry.

TiO_2 Pigment

Rikkihappo is also supplying the sulphuric acid needs of the new 16,000 t.p.a. TiO_2 plant of Vourikemia Oy at Mantyluoto, which came on stream at the end of May. This, the first TiO_2 pigment plant in Finland, derives its ilmenite supplies from the Otanmaki mines. The sulphuric acid is obtained from Rikkihappo's new 60,000 t.p.a. (100% H_2SO_4) acid plant built by Hugo Petersen of Wiesbaden and which is based on the use of SO_2 in smeltergases from the copper melters of Outukumpu Oy. The bulk of waste copperas ($FeSO_4$ $7H_2O$) will be discharged, but a small proportion will be crystallized and stored.

Sulphuric Acid and Sulphur in Australia

Fertilizer industry continues to determine requirements

PRODUCTION of sulphuric acid in Australia in 1960 rose 10.9% to 1,109,751 tons 100% H_2SO_4, mainly attributable to the increase in the output of brimstone acid which rose 17.3% to 549,699 tons 100% H_2SO_4. Although the output of sulphuric acid from indigenous raw materials rose 5.3% to 560,052 tons 100% H_2SO_4 the relative importance in the raw materials supply pattern declined and in 1960 only 50.5% of total acid output was based on indigenous raw materials compared with 53.2% in 1959. There were no significant changes in the quantities of sulphuric acid produced from pyrites and from spent oxide. By-product sulphuric acid at zinc smelters increased 7.6% to 131,338 tons 100% H_2SO_4 while acid produced from other sulphurous raw materials—lead smelter gases, spent alkylation acid and hydrogen sulphide extracted from oil refinery gases—increased by 19.4% to 97,768 tons (100% H_2SO_4). Despite this substantial increase this raw material source still only accounts for less than 9% of total acid output.

Raw Materials

Consumption of imported brimstone for sulphuric acid in 1960 increased by 17.1% to 187,262 tons and that for non-acid uses rose 7.8% to 15,196 tons. The grade of pyrites and pyrites concentrates consumed in 1960 appears to have declined slightly as consumption of 253,295 tons was over 1% greater than the corresponding increase in pyrites acid production. On the other hand, the grade of spent oxide used appears to have improved. Increased operations at the Shell Oil Refinery at Geelong resulted in significantly higher supplies of hydrogen sulphide and it is this source of supply which accounted for the large increase in acid output from "other sources."

Consumption

The main impetus to the expansion of sulphuric acid production in 1960 was given by the higher demand for superphosphate manufacture. In this sector acid consumption rose to 837,136 tons (100% H_2SO_4) while sulphuric acid used for production of ammonium sulphate rose by 4.3% to 79,586 tons (100% H_2SO_4).

Although ammonium sulphate production, as the result of modest improvements in the second half of 1960, increased slightly, the unfavourable outlook which became evident in the fertilizer year 1959-60 is little changed. Heavy imports of competing fertilizer materials such as urea, and to a lesser extent complex fertilizers, have reduced demand for ammonium sulphate, despite the reduction of the ammonium sulphate price from £A35 per ton in 1958 to £A26 in 1960 whereby producers hoped to maintain their hold on the domestic nitrogen

Raw Material Consumption

	1959	1960	Difference	% change
	Long Tons			
Imported Brimstone for acid	159,922	187,262	27,340	+17.1
for other uses	14,094	15,196	1,102	+ 7.8
Pyrites	248,841	253,295	4,454	+ 1.8
Zn. concs.	156,501	170,626	14,125	+ 9.0
Spent oxide	10,495	10,309	186	− 1.8
Others	283,309	269,048	14,261	− 5.0
H_2SO_4 Production				
ex Brimstone	468,487	549,699	81,212	+17.3
ex Pyrites	316,807	319,282	2,475	+ 0.8
ex Zn. concs.	122,119	131,338	9,219	+ 7.6
ex Spent oxide	11,179	11,664	485	+ 0.4
ex Others	81,866	97,768	15,902	+19.4
Total	**1,000,458**	**1,109,751**	**109,293**	**+10.9**

Raw Materials Consumption				
			(Long tons)	
H_2SO_4 Consumption				
for Superphosphate	738,742	837,136	98,394	+13.3
for Ammonium Sulphate	76,343	79,586	3,243	+ 4.3
for Others	183,097	191,582	8,485	+ 4.6
Total	**998,182**	**1,108,304**	**110,122**	**+11.0**
Superphosphate				
Production	2,150,413	2,450,329	299,916	+13.9
Sold	2,142,231	2,392,754	250,523	+11.6

fertilizer market. To protect the domestic market the Australian Government has as from 24 May 1961 imposed a duty of 25s. per cwt. on ammonium sulphate and of 12½% on other nitrogenous fertilizers but exempting certain specified N products from liability to duty.

Three plants previously producing ammonium sulphate had ceased to produce by the end of June 1960. To clear an accumulated surplus Electrolytic Zinc Company exported in the second half of 1960 some 20,000 tons to China at world export prices which are substantially below the domestic price level, and at present supply has been brought into balance with demand.

Industrial Uses Increase

Industrial uses of sulphuric acid in 1960 totalled 291,582 tons (100% H_2SO_4) an increase of 4.6% over 1959 but still only representing 17.3% of total acid use (18.3% in 1959). The largest single user is Australian Titan Products at Burnie, Tasmania, consuming about 35,000 tons acid in pigment manufacture. Oil refining, metallurgy—notably uranium ore refining—and steel pickling represent other major uses.

Prices

Brimstone imported into Australia by the British Phosphate Commissioners on behalf of all consumers, is distributed by way of a Sulphur Pool at a fixed prices which represents average f.o.b. cost of sulphur imported from various sources, cost of freight and other charges. Average f.o.b. costs of brimstone of U.S. origin are reported at £A10 18s. 7d. per ton in the second quarter and £A10 8s. 6d. in the third quarter of 1960, whereas f.o.b. costs of brimstone of Mexican origin in these periods were £A10 5s. 3d. and £A9 10s. 2d. respectively. The pool price which had been reduced by £A1 15s. 0d. in July 1959 and again in July 1960 by £A remained unchanged at £A15 per ton during 1960.

Sulphuric Acid Bounty

Since the early 1950's until 1959 the policy of the Australian Government had been to encourage the production in Australia of sulphuric acid from indigenous sulphur-bearing materials. The main material used has been iron pyrites. In 1958-59 total sulphuric acid production amounted to almost one million tons, and of this 35% was derived from pyrites. Since 1954 the Government has paid a bounty to producers of sulphuric acid using iron pyrites to compensate them for the additional cost involved in using these materials compared with imported brimstone. Since 1957 bounty has also been paid on acid produced from lead smelter gas.

In line with this policy of encouragement the Tariff Board in 1958 recommended increased rates of bounty. There had been, however, a considerable improvement in the overseas supply position for brimstone and in May 1959, the Government decided, that in views of the extra costs involved in using pyrites and other Australian materials, there was no longer economic justification for continuation of the bounty.

In making this decision the Government recognised the obligation to those producers of acid and sulphur-bearing materials who had co-operated or planned to co-operate in the previous policy. The recommendations in the Tariff Board's 1958 report were not adopted and instead the board was asked to recommend a bounty, which, while not conflicting with the Government's decision to abandon the encouragement policy, would yet reflect its obligations to the producers mentioned above. The board delivered its report on 20th June, 1960, and as the then current Act was due to expire on 30th June, 1960, the bounty was extended for six months to 31st December, 1960. In fact, the board has recommended an extension of the bounty for a further period of

five years, with separate rates of bounty for sulphuric acid made from iron pyrites and for iron pyrites itself; no bounty was recommended for acid produced from smelter gas.

Bounty Rates

Alternative bounty rates of £A3 or £A5 4s. per ton of 100% sulphuric acid had been proposed by the Tariff Board, either of which could be adopted by the Government in the light of what it considered to be its obligations to the producers concerned. The lower rate measured the average disability of producers, the higher rate the disability of the highest cost producer.

In December 1960 a Bill was presented designed to give effect to the board's proposals for sulphuric acid and the rate of bounty prescribed in the Bill is that based on the average disability of producers and it is pointed out that even when it was the Government's policy to encourage production of sulphuric acid from indigenous materials, the bounty was based on average disability, and not on the disability of the highest cost producer.

With regard to payment of bounty on sulphuric acid made from lead smelter gas, the only producer—Broken Hill (Pty.) Limited at Port Pirie—is now no longer under a cost disability through use of SO_2 in smelter gas compared with brimstone. The board therefore recommended and the Government accepted the recommendation that no bounty be paid on acid made from lead smelter gas. The only recipients of the bounty will be those producers who have been producing sulphuric acid from iron pyrites before the introduction of the Bill of December 1960. Producers who before this date had incurred substantial commitments to start production will be allowed a period of six months in which to apply to the Minister for consideration as possible beneficiaries of bounty in the future.

No alteration has been made to the rate of profit limitation which at 12½% is the rate which has applied on sulphuric acid since the introduction of the bounty in 1954.

Pyrites Bounty Bill

Also put before the Australian House of Representatives in December 1960 was a Bill designed to put into effect the Tariff Board's proposals regarding iron pyrites. The board proposed two alternative basic rates, £A3 or £A7 per ton of sulphur contained in pyrites. The lower rate is based on the average disability of producers, the higher rate on the disability of the highest cost producer. As with sulphuric acid the Government adopted the lower rate and this is to be increased or decreased by the same amount, to the nearest 1s., as the landed (duty-free) cost per ton of brimstone falls below or rises above £A16.

Again bounty will be restricted to those producers to whom the Government recognises an obligation. Accordingly, the only recipients will be those producers of iron pyrites who have been in operation before the introduction of this Bill. The rate of profit limitation—12½%— is the same as provided for sulphuric acid under the current act and as proposed under the new Sulphuric Acid Bounty Bill.

West Australian Pyrites

The West Australian Government extended temporarily for three months to 31st March, 1961, the freight subsidy and concessions on pyrites from Kalgoorlie and Norseman, at a cost of £79,000 a year at present production rates. The concession was increased in September by 12s. 5d. to £A1 5s. 2d. per ton pending the decision on the Commonwealth Sulphur Bounty. These pyrites producers will now also receive Commonwealth bounties estimated at £69,600 a year which combined with the State subsidy will bring total benefits to some £7 5s. per ton of sulphur in pyrites, making it competitive with imported brimstone at £A15 per ton. These benefits do not affect the acid Bounty which may be claimed by sulphuric acid and superphosphate producers to offset higher processing costs of pyrites. Norseman Gold Mines N.Z. reported for the year ending October 1959 an average realisation of 3.26 A. shillings per unit S in pyrites compared with 3.29 A. shilings in 1959 and 3.16 A. shillings in 1957.

New Developments

During the second half of 1960 the new 250 t.p.d. (100% H_2SO_4) sulphuric acid contact plant of Sulphide Corporation at Cockle Creek, New South Wales, was completed, and started

operations based on elemental sulphur. The new zinc smelter came into operation at the end of 1960 and starting in early June 1961 SO_2 in zinc smelter gases has been used for the manufacture of sulphuric acid, replacing part and ultimately all the brimstone feed.

Australian Fertilizers Limited at Port Kembla brought on stream in the second half of 1960 a 40,000 t.p.a. (100% H_2SO_4) contact acid plant. Originally designed for Frasch sulphur (55%) and SO_2 in copper smelter gases (45%), the disposal of the output of copper concentrates from Peko Mines to Japan has prevented the copper smelter operating and the acid plant appears to be wholly based on brimstone. Total installed sulphuric acid capacity in Australia is currently estimated at 1,260,000 tons (100% H_2SO_4).

Outlook

Although development in Australia's fertilizer industry will continue to exert the strongest influence on sulphuric acid and sulphur requirements, the large expansion foreseen in the manufacture of titanium oxide pigments between now and 1965 can also be expected to make a major impact on the Australian sulphuric acid picture. In fertilizers, continued expansion is expected in the manufacture of superphosphates which in 1960 totalled 1,450,329 tons and which are expected to increase at a cumulative rate of 5% p.a. As yet there is no project for the production of phosphoric acid, although the possibility of its manufacture has been examined in several quarters. Installed capacity for titanium pigments is at present 12,000 tons TiO_2 following the 20% increase at the Burnie works of Australian Titan Products (Pty.) Limited. This subsidiary of British Titan Products Limited plans to increase its pigment capacity to 16,000 tons by the end of this year and to raise it to 22,000 tons by 1964/5. At the same time Laporte Titanium Ltd. plans to establish a titanium pigment plant at Bunbury, Western Australia, which is expected to come on stream in 1964 with an annual capacity of 10,000 tons. These projects will require some 80,000 tons of new sulphuric acid.

Rapid expansion is also evident in the oil refining, petrochemicals and general chemicals industries and this will be reflected in greater sulphuric acid demand. Amongst new developments of particular interest is the projected manufacture of caprolactam and nylon 6 by Polymer Corporation in which the International Division of Allied Chemical Corporation of New York is reported to have a major interest. The resultant by-product ammonium sulphate can be expected to affect adversely the future growth of synthetic ammonium sulphate production in Australia.

Although the continuation of subsidy payments to users of indigenous pyrites has been extended on new terms for a further five years and pyrites producers themselves will also benefit from a bounty it is expected that the bulk of new sulphuric acid requirements in Australia will be based on imported brimstone. Part of the additional acid demand will be met from by-product sulphuric acid from zinc smelting gases and already Electrolytic Zinc Company of Australasia Limited is considering an expansion at Risdon by 120 tons a day (100% H_2SO_4).

Developments in this sector are of course entirely dependent on a ready outlet for sulphuric acid and this factor would prevent the utilisation of sulphur in stack gases at locations such as Kalgoorlie where, according to the chief chemical engineer of the Western Australia State Chemical Laboratories, about 20,000-25,000 tons sulphur, representing one half of Western Australia's sulphur imports, is exhausted to the atmosphere.

Increased oil refinery activity can be expected to result in additional quantities of hydrogen sulphide becoming available which may be converted direct to sulphuric acid as is the case at the Shell refinery at Geelong, or to elemental sulphur. The Standard Vacuum Oil Company is reported to have projected a major refinery where an elemental sulphur recovery plant is expected to be part of the installations.

At present Australia imports brimstone at an annual rate of 225,000 tons, of which approximately two-thirds is of U.S.A. and one-third of Mexican origin. The imminent entry of Canada into world sulphur markets can be expected to introduce a third supplier into the Australian market as from the viewpoint

of ocean freights Vancouver is favourably located. In addition to the anticipated expansion of sulphur demand of the sulphuric acid industry, and the various non-acid industries using brimstone, notably carbon disulphide, increasing quantities of brimstone are consumed as additive to single superphosphate. In Australian soils sulphur deficiency is widespread and although gypsum is widely applied "fortified superphosphate" in which brimstone addition is as much as 17% w/w which raises the sulphur content for superphosphates to 27-28%, is finding increasing favour with farmers. It can be expected that import demand in Australia will rise progressively to 270,000 tons by 1965.

Determination of Sodium Sulphide and Mercaptans in the Presence of Each Other

Accuracy of New Polish Titration Method

SULPHIDE and aliphatic mercaptans can be accurately determined by titration with *o*-hydroxymercuribenzoic acid using thiofluorescein or dithizone as indicator, Mieczyslaw Wronski, Department of Chemical Technology, University of Lodz, Poland, has reported (1) (2).

The *o*-hydroxymercuribenzoic acid has been obtained as the anhydride from Polskie Odczymike Chemiczni, Oliwice, Sowinskiego 11, Poland. In the method described below, use is made of the rapid reaction between mercaptans and acrylonitrile reported by J. Mitchell *et al.* (3); under the same conditions, sulphide reacts very slowly. Therefore to determine sodium sulphide and mercaptans in the presence of each other sulphide plus mercaptan is titrated in one sample and sulphide only in the second sample after the mercaptan is removed with acrylonitrile. The mercaptan content is calculated from the difference between the two titrations.

Wronski's Procedure

Describing his procedure in *The Analyst* (1960, *85*, 527) Wronski, for sulphide plus mercaptan, adds to a solution of the alkali sulphide and mercaptan 5 c.c. of N ammonium hydroxide and 1 c.c. of 0.02% w/v thiofluorescein, and dilutes the whole to 100 c.c. with water containing about 0.1% of sodium sulphide. The solution is titrated with 0.001 to 0.05 N *o*-hydroxymercuribenzoic acid until the blue colour sharply disappears. For determination of sulphide a solution of alkali sulphide and mercaptan are added to 5 c.c. of N ammonium hydroxide and a methanolic solution of acrylonitrile (about 2 moles for each mole of mercaptan). The solution is allowed to stand for two to 15 minutes depending on dilution and the mercaptan present (two minutes are sufficient for between 2 and 40 mg. of methyl mercaptan in 20 c.c. solution), then dilute to 100 c.c. and titrated with *o*-hydroxymercuribenzoic acid, thiofluorescein being used as indicator.

Ethyl mercaptan, thioglycollic acid and cysteine can be determined similarly in the presence of sulphide. If the sample contains sulphide, mercaptan and cyanide, the cyanide and sulphide plus mercaptan are determined as described previously for sulphide plus cyanide (4), and in a third sample, after removal of mercaptan by acrylonitrile and cyanide by formaldehyde the sulphide above is titrated with *o*-hydroxymercuribenzoic acid, a solution of dithizone in sodium hydroxide being used as indicator. The presence of SO_3^{2-}, $S_2O_3^{2-}$ or CNS^- ions does not interfere in either titration.

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(2) „ Scientific Reports of Lodz University, 1958, 4, 181.

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Decrease in Mexico's Sulphur Production

Export sales and domestic demands increase

IN 1960 production in Mexico decreased by 3% to 1,342,000 tons but deliveries rose 17.7% to 1,352,000 tons. Higher export sales accounted for the greater part of the increase but Mexico's domestic requirements which were 19% greater than in 1959, rose faster. Sulphur stocks in Mexico declined 27,000 in 1960 to about 1,023,000 tons.

The outstanding feature of Mexico's economy in 1960 was the continuing high rate of growth of industrial activity. The level of foreign trade also continued to expand but the results were adversely affected by the recession in international raw materials markets, notably of non-ferrous metals and ore and low commodity prices, especially of sulphur.

Among the country's activities the expansion in the oil, iron and textile industries was prominent and great strides were made in all chemicals manufacture, including fertilizers and sulphuric acid.

Production

The reduction of Mexican brimstone output to 1,342,000 tons—3% less than in 1959—is attributable almost entirely to the lower production of Frasch sulphur and to a small extent to decreased output of refined sulphur based on native ores.

Pan American Sulphur Company (PASCO) which accounts for over 76% of Mexican brimstone output, substantially increased its level of production but the effect of this is outweighed by reduced output of Gulf Sulphur Corporation and the cessation of production at Texas Gulf Sulphur Company's Nopolapa Dome. The most notable change has been in the output of recovered sulphur which increased 21%.

Deliveries

Brimstone deliveries by Mexican producers rose 17.7% to 1,350,000 tons. Export shipments —exclusively by PASCO and Gulf Sulphur— totalled 1,170,800 tons, an increase of 13% compared with 1959. PASCO shipped 79,000 tons more to consumers and also some 33,000 tons to stock piles in the U.S.A. and in Rotterdam while Gulf Sulphur increased exports by 63,000 tons. Domestic deliveries rose 28,000 tons (19%) to 145,000 tons represented by deliveries of brimstone refined from native ores, recovered from natural and oil refinery gases and Frasch sulphur. Both PASCO and Gulf Sulphur increased their deliveries to home market by 2,000 tons and 8,000 tons respectively.

Exports

Despite the decrease of 5.2% in 1960 of Mexican export deliveries to the U.S.A., this market remains Mexico's largest outlet, representing slightly over one-half of total exports of 1,170,800 tons. The outstanding feature of the 1960 marketing pattern is the substantial increase of deliveries to Europe which rose 47.2%. Shipments to Australia and New Zealand more than doubled and with the exception of a slight decrease of deliveries to South and Central America, as yet a small

Sulphur in Mexico 1960
'000 tonnes

	Recovered			
	Frasch		Native	Total
Production	1,240	85	17	1,342
change from 1959	(− 4%)	(−21%)	(−5%)	(− 3%)
Deliveries	1,252	83	17	1,352
change from 1959	(+19%)	(+20%)	(−5%)	(+17.7%)
To Exports	1,172	—	—	1,172
change from 1959	(+14%)			(+14%)
To Overseas Stockpile	35	—	—	35
To Domestic Market	45	83	17	145
change from 1959	(+29%)	(+20%)	(−5%)	(+19%)
Stocks (31.12.60)	1,056	†	†	1,060*

† No date * Estimated

market, deliveries to all other main consuming areas rose.

The overall increase of 140,500 tons (14%) was achieved under conditions of intensive world wide competition.

The decline of shipments to North America has to be viewed against the background of the comparatively small expansion of this sulphur market which at the same time received substantially increased deliveries of recovered sulphur of U.S. and Canadian origin. The increase of deliveries to Europe is attributable mainly to booming brimstone demand which is reflected by the overall increase of imports from all sources—U.S., French, as well as Mexican sulphur—of 1,729,000 tonnes.

Significantly higher sales were achieved in West Germany, mainly by Gulf Sulphur Corporation in the form of off-colour sulphur. Increased shipments to Belgium are mainly attributable to PASCO, which also secured higher deliveries to U.K., East Germany, Poland, Portugal and Finland. In the last named three markets Mexican sulphur appeared for the first time. Markets in Sweden, Switzerland and Yugoslavia were lost primarily because of competition by French sulphur which also contributed to the poorer showing of Mexican sulphur in Austria and the Netherlands.

Domestic Sales

Recovered sulphur remains the main source of supply to the Mexican home market which also consumes the entire output of brimstone refined from native ores mined near San Luis Potosi in the north of the country. Both these sources are limited and for the immediate future have reached their limit. To meet the rapidly rising domestic needs more Frasch sulphur is being used and the notable increase in 1960 of 10,000 tons is indicative of the trend. Total domestic consumption in 1960 rose 19% to 145,000 tons.

Frasch Sulphur

Pan American Sulphur Company. As the result of the higher level of extraction of over 3,000 tons a day at Jaltipan dome in the late spring of 1960 the company's production during the year increased 139,000 tons 15.7% to 1,022,000 tons, the highest on record and the third largest output of any single brimstone producer in the world.

Shipments in 1960 totalled 977,000 tons, an increase of 15.5%, which brings the total shipped by the company to date to 3,837,000 tons. In addition to exports of 909,000 tons directed to almost every important sulphur consuming area of the world, and domestic deliveries of 33,000 tons, PASCO shipped 35,000 tons to the company's stock piles at Rotterdam, established in 1960, and to Tampa, Florida, where last year 183,000 tons sulphur passed through on the way to customers. At the end of 1960 the company's stocks totalled 625,000 tons of which 590,000 tons was held in Mexico.

New Installations

At Jaltipan during the year under review, a liquid sulphur storage tank and a second sulphur filtration unit were installed. Also brought on stream at Jaltipan was a 15 t.p.d. sulphuric acid plant which provides the acid needs for sulphur purification and which will also be used in a study programme of sulphuric acid plant variables*. At the Tampa terminal, sulphur handling and storage facilities were completed and following the mounting demand for molten sulphur, delivery provisions for a major liquid sulphur delivery programme were initiated. Liquid sulphur shipments in a con-

Mexican Sulphur Exports

	1959	1960	Change tons	%
North America	627.5	589.9	− 37.6	− 60 %
Europe	199.3	293.0	+ 93.7	+ 47.2%
Australasia	59.1	120.1	+ 61.1	+103 %
South Africa	59.5	66.6	+ 7.1	+ 11.9%
Asia	24.3	31.9	+ 7.6	+ 31.3%
Central and South America ...	15.3	14.6	− 0.7	− 4.6%
N. Africa and Middle East ...	45.2	56.1	+ 10.9	+ 24.1%
	1,030.2	**1,172.2**	**+172.0**	**+ 13.8%**

* SULPHUR No. 32, February 1961, Page 37.

	'000 tons			
	1959	1960	Change '000 tons	%
Production	887	1,022	+135	+15.7%
Total Deliveries	861	957	+116	+13.5%
Export Sales	830	909	+ 79	+ 9.5%
Overseas Stockpile	—	35	—	—
Domestic Sales	31	33	+ 2	+ 6.4%
Year end Stocks in Mexico	580	625	+ 45	+ 7.8%

verted T2 tanker "*s.s. Etude*" started in May 1961*. The estimated cost of the necessary handling and storage facilities at Tampa is about $8.25 million.

Gulf Sulphur Corporation. During 1960 the company's production declined 79,000 tons (−28%) to 203,000 tons. In the main the decline of production was attributable to mining operations being carried out at a depleted section of the mine. At present the company intends clearing up the area of the Mezquital mine from which it has been producing for more than two years and a new area of the mine is being prepared from which the company will shortly be producing. In October 1957 the Las Salinas structure was estimated to contain over 5.5 million tons sulphur of which, up to the end of 1960, 1.05 million tons had been produced. Additional sulphur reserves estimated at 730,000 tons are thought to exist at a north-east extension of the ore body and a south-west extension of the Salinas structure may contain 350,000 tons sulphur.

Total deliveries in 1960 of 275,000 tons were, however, the highest on record and 716,000 tons (34.8%) greater than in 1959.

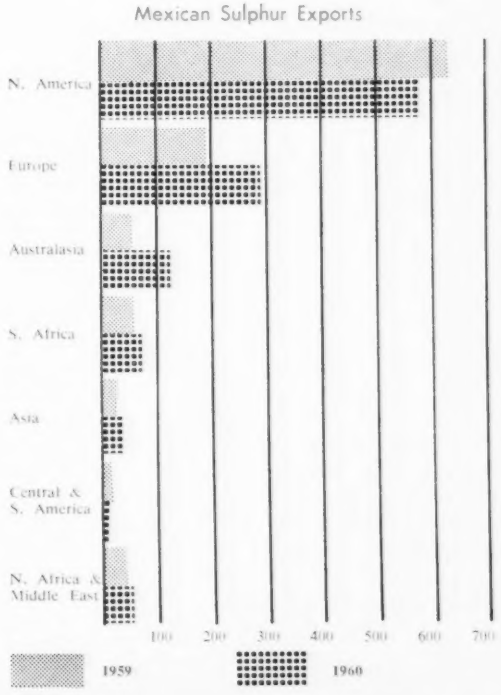
During the year stocks declined 72,000 tons to 31,000 tons at the end of December.

During 1960 the company's average realisation on sulphur sales further declined to $20.11 per ton f.o.b. At the same time the average cost of production, transport to docks, loading and marketing rose to $18.32. As the result of the increasingly difficult financial situation of the company a project of recorganisation was submitted to the shareholders in the latter part of 1960 and in January of this year this was completed by merging Gulf Sulphur Corporation with its wholly owned subsidiary, the Latino Sulphur Corporation†.

	'000 tons		
	1959	1960	% Change
Production ...	282	203 (−79)	− 28 %
Total Deliveries	204	275 (+71)	+ 34.8%
Export ...	200	263 (+63)	+ 31.5%
Domestic ...	4	12 (+ 8)	+200 %
Year end Stocks	103	31 (−72)	− 70 %

Texas Gulf Sulphur Company. In February 1960 this company ceased to produce at the Nopolapa dome where the entire output remained stockpiled.

	1959	1960	
Production	120	15	'000 tons
Year end stocks ...	350	365	'000 tons



* Current Events, Page 35.

† SULPHUR No. 33, April 1961, Company Reports, Page 46.

Texas International Sulphur Company. Total output in 1960 at the company's Texistipec dome is reported at only 500 tons, due to financial difficulties and reorganisation of the management. Since January, 1961, Central Minera, an affiliate of Texas International Sulphur Company, has been in regular production and output of 2,400 tons in January was followed by 2,480 in February. The company is reported to have obtained financial assistance from U.S. banks which will enable it to purchase and install additional machinery and equipment and operate more wells. A noticeable increase in output is expected in the course of this year.

Petroleos Mexicanos. Output of recovered sulphur by Petroleos Mexicanos rose 85,000 tons, an increase of 21% compared with 1959 The output originated from the company's sour natural gas plant at Poza Rica which has a daily capacity of 140 tons S, and the sulphur recovery plant at the Madero oil refinery at Tampico (30 tons sulphur a day) and Mexico City (25 to 28 tons sulphur a day).

	'000 tons		Tons Change	
	1959	1960		%
Production ...	70	85	+15	+25
Sales	69	83	+14	+20
Addition to Stocks	+1	+2		

For the time being no change in the level of recovered sulphur production is anticipated especially since the Mexican Government is reported to have curtailed the rate of the company's capital spending. This may delay the gas pipeline project which is intended to link Reynosa to Mexicali in Baja, California, a distance of some 1,200 miles, by a 34-inch line. When completed at an estimated cost of $6.6 million some 750 million cu. ft. of gas would be carried daily of which 450 million cu. ft. are intended for export to the U.S.A. The resultant increase in sour gas production and its treatment would raise recovered sulphur production from its present monthly rate of 7,000 tons to 12-15,000 tons.

New Sulphuric Acid Capacity

Zincamex S.A., a subsidiary of Comision de Fomento Minera, is building a zinc refinery which will have a yearly capacity of 30,000 tons of special high grade zinc, and facilities for approximately 60,000 tons (100% H_2SO_4) by-product sulphuric acid. The site for the refining and sulphuric acid plants will be Saltillo, Coahuila; the new plant will be engineered, supplied and built by Sybetra S.A. of Brussels, Belgium and will be based on the Overpelt-Lommel zinc process. The wholly-owned subsidiary of E.I. du Pont de Nemours and Company, U.S.A., Compania Mexicana de Explosives S.A., of Mexico City, is to erect a 30 short tons a day sulphuric acid concentration plant of the submerged combustion type. Contract for the supply of process design and detailed engineering services has been awarded to Chemical Construction (G.B.) Limited, London, England.

Between 1950 and 1960 sulphuric acid production has expanded from 42,700 tons to 244,000 tons in 1960 and an annual expansion in excess of 10% is foreseen.

Fertilizer Developments

Efforts by Petroleos Mexicanos (Pemex) to set up a strong petrochemical industry that will supply to private industry basic raw materials to the benefit of Mexico's national economy, are now being realised.

One of Mexico's first private enterprises to make use of Pemex ammonia supplies is Fertilizantes del Istmo S.A., at Minatitlan, Veracruz. For the manufacture of fertilizers the company will produce sulphuric acid — 55,000 tons a year (100% H_2SO_4) — based on Frasch sulphur from the nearby domes on the Isthmus of Tehuantepec; phosphate rock from Florida will be imported for production of 42,000 tons of triple superphosphate and 40,150 tons of diammonium phosphate. Investments of 100 million pesos (£2.9 million) are foreseen. Pemex holds 20% of the share capital, the majority is reported to be held by a major U.S. fertilizer manufacturer.

Fertilizantes de Monclova S.A., also a nitrogen fertilizer producer, completed its sulphuric acid plant at Monoclova in Coahuila last year.

The fertilizer works of Guanos y Fertilizantes S.A. at Coatzacoalcos is now in operation and 150 tonnes a day of triple superphosphate is produced. Wholly Mexican owned, this company is a consumer of one of Pemex first petrochemical products—sulphur recovered

at Poza Rica. The company is to invest 60 million pesos (£1.7 million) in the construction of a plant to manufacture calcium superphosphates at Veracruz, which is due to come into production this year.

Developments at Monterrey, a centre of growing industrial activity, may include fertilizer production, based on the local siliceous phosphate ores. American Potash and Chemical Corporation is reported to be investing 15 million pesos (£430,000) in a joint U.S./Mexican venture to develop a fertilizer project which may ultimately employ 600 workers.

Textiles

The most dynamic section within Mexico's textile industry is synthetic fibres and in the last 10 years their development has been such that the industry is now among the ten most important in the country.

Of a total production of 18,687 tonnes of chemical fibres produced in 1959, rayon accounted for the largest volume while acetate filament rose by 21.1% from 9,165 tonnes in 1958 to 11,098 tonnes in 1959.

Recently Celanese Mexicana S.A., announced that it is now concentrating on the production of synthetic fibres, cellophane and related items at its plant at San Cristobal, Ecatepec.

Outlook

During 1961 a slight decline in overall sulphur production in Mexico is anticipated despite the activities of Texas International Sulphur which can be anticipated to produce between 30,000 and 50,000 tons. As yet there is no indication whether the new producers' output is to be marketed abroad and the entire output to date has been placed on the domestic market.

PASCO's production in 1961 according to the company's president, Mr. Harry C. Webb, will balance anticipated shipments of approximately one million tons. Output of Gulf Sulphur is expected to total about 200,000 tons.

No significant change in Mexico's exports is expected in 1961 but her domestic requirements are likely to increase by at least 10,000 tons. On April 6th a new Mexican mining law was promulgated but its effect, if any, on the country's sulphur industry is not yet clear. By the new law the Government can determine production quotas if it is thought desirable, which, if enforced, could boost the necessarily careful production plans of the major companies. Their prosperity is now of major importance to the Mexican Government partly because sulphur as the sixth largest foreign currency earner makes an important contribution to the country's trade balance and the industry has also become an important employer of labour and contributor to tax revenues in a development area.

In the longer term, the expansion of the industry is assured not only because of rising world sulphur demand but especially because of the rapid development of Mexico's industries of which fertilizers, paper, textiles, detergents and steel in particular will make increasing calls on sulphur supplies.

Overseas Nordac Plants

INSTALLING a submerged combustion sulphuric acid recovery plant* at Rheinpreussen A.G., Homberg, W. Germany, is Nordac Limited, Uxbridge, Middlesex. The plant will reconcentrate acid obtained as by-product in the process used for producing isobutanol.

Other Nordac sulphuric acid recovery units have recently been despatched to Czechoslovakia for recovery of both sulphuric acid and hydrochloric acid from a mixed effluent, again using the submerged combustion evaporators; the hydrochloric acid is recovered from tail gases in an absorption system†.

In addition, two large sulphuric acid recovery plants are being sent by Nordac to the U.S.S.R. Both plants will reconcentrate waste acid to prevent pollution of rivers. It appears that the U.S.S.R. is particularly concerned about preventing river pollution.

The ferrous monohydrate crystals obtained using the Nordac submerged combustion plant are suitable for roasting either by the Lurgi type roaster as installed at the Steel Company of South Wales' plant or by the Dorr-Oliver fluid-bed roasters, as installed at British Titan Products' Grimsby plant.

* See Sulphur Sepecial Issue 1960. † For Chemo-Pharma

European Pyrites Prices Unchanged

THE decision by the European producers of pyrites to maintain the present level of prices during the second half of 1961 comes at a time when the momentum of upward pressure of brimstone prices has slowed down. In the U.S.A. the price increases of up to $2 per ton of brimstone, foreshadowed at the close of 1960, will be applied by all major suppliers after the end of this month and it is expected that the bulk of deliveries to U.S. consumers will be shipped at prices resulting in an f.o.b. equivalent of $23.50. This price level has been in force since the beginning of 1961 in respect of the growing volume of Frasch sulphur exports from U.S.A. and Mexico. It had been the suppliers' intention to make it more widely effective, in particular in a number of West European countries, during the second half year but it now appears that no further increases in brimstone price will be made for the time being.

Competition with Brimstone

Maintenance of the level of pyrites prices reflects the hardening determination of the producers to offer more effective competition to brimstone and to ensure that a larger proportion of total European sulphur use is represented by pyrites. In this respect it is significant that a number of major pyrites producers were ready to lower prices, thus widening even more the already large gap between the cost of sulphur in pyrites and that of brimstone. Last year, mainly because of booming sulphur demand in Europe, the level of exports by the European pyrites producers rose 19% over that in 1959 and was also nearly 10% higher than in 1958. Although substantial, this expansion was smaller than that enjoyed by suppliers of brimstone to this market. The cause is not far to seek and it represents the principal impediment to future prospects for pyrites in Western Europe. Of some 20 new sulphuric acid plants brought on stream in Western Europe during the past two years none was based on pyrites and the only new equipment in this sector was the installation of new roasters by a number of major pyrites users in replacement of old furnaces.

Joint Projects

Whereas the price advantage of sulphur in pyrites over brimstone can promote its use up to the level of installed capacity there are as yet no signs that it is sufficiently attractive to compensate for the incidence of higher capital cost—up to 2½ times greater than for a brimstone acid plant—which is undoubtedly the main deterrent to acid makers contemplating expansion or faced with wholesale replacement of obsolete plant. The only two major pyrites acid installations at present under construction—the Albatros/Cyprus Mines Corporation project at Pernis and the Sachtleben AG. project in the Ruhr—provide a pointer towards overcoming this disability. In both instances producers of pyrites have provided a proportion or all the capital required for the erection of a pyrites acid plant, thereby assuring a substantial new long-term outlet for their product.

Share of European Market

In 1960 sulphur consumption in all forms in Western Europe advanced 10.5%, brimstone consumption rose 21.8% and pyrites only 8.3%, with the result that of the total sulphur consumption of 7.3 million tonnes the share of pyrites receded to 49.2% compared with 50.3% in 1959, whereas brimstone accounted for 29.1% against 26.4% in 1959. If pyrites suppliers are to succeed in their endeavour to reverse the adverse trend—in 1955 pyrites represented 58.4% of total sulphur use in Western Europe with a tonnage 9% smaller than that consumed in 1960—or if only to slow it down, their sales promotion, which at present rests on the favourable foundations of a low unit sulphur price and a high and stable residues value, will have to encompass measures to meet the consumers' main criticisms of the

disproportionately high cost of new pyrites plants and of contamination by pyrites or residues of secondary chemical processes, notably in petrochemicals, catalyst, pigments and pulp manufacture.

PRICES

Frasch Sulphur

U.S.A. Posted prices of U.S. bright sulphur producers remain unchanged at $25 per ton f.a.s. U.S. Gulf ports; discounts of $1 apply in respect of off-colour sulphur and of $1.50 in the case of deliveries f.o.r. *ex* mine. Posted prices still only apply in a limited number of protected markets and the bulk of domestic deliveries and exports sales are based on delivered prices embodying freight contributions or other discounts of up to $3.50 per ton. During the first half of 1961 the bulk of U.S. Frasch sulphur sold on the home market appears to have been priced at a f.o.b. equivalent of between $22 and $23. Price increases of up to $2 per ton announced by the major producers in December 1960, which had hitherto applied only to a small number of new customers, are to take more widespread effect after the end of this month and according to one producer all his contracts from July onwards are to be based on the new prices. Hitherto delivered prices of solid and liquid sulphur in Florida (Tampa area) ranged from $25 to $27, in the North Central States and the Great Lakes area $26 to $27 and along the Atlantic Seaboard around $26.50.

The new prices are expected to raise the f.o.b. equivalent to $23 to $24 per ton, a level which results from most of the current export business. The producers' objective to transact their home and export sales at posted prices remains unaltered.

Mexico. Posted prices of both Frasch sulphur producers engaged in exports are $23.50 per ton f.o.b. Coatzacoalcos for bright sulphur and $22.50 for off-colour material. Since last December these prices have been applied to an increasing volume of sales in the U.S.A. and markets elsewhere notably in West Europe, but the extent of existing engagements is not inconsiderable and effective returns although higher than a year ago still average well below the posted price level.

Export Prices

In Western and Northern Europe delivered prices of U.S. and Mexican bright Frasch sulphur range from $26.50 to $31 per ton c. & f. No change in delivered price is foreseen for the second half year although price differentials on shipments entering through North-West European ports for various consumers in West and Central Europe are causing some concern. French recovered sulphur is sold competitively within the above price range. The small volume of Italian sulphur is exported to nearby destinations at Lire 17,100 per tonne. Limited quantities of Russian sulphur were purchased in Western Germany and by a small number of consumers in other Western European countries, although not so far in the U.K. In these areas it is offered at prices of $22.50 to $24.50 per tonne c. & f.

Delivered prices in India, the Far East and South America have risen as a corollary of higher ocean freights. In India Frasch sulphur of U.S. and Mexican origin and most recently also the first cargoes of French recovered sulphur are landing at prices ranging from $32 to $34 per ton c. & f. In South America, a number of shipments appear to have attracted freight rates of up to $3 higher than in recent months with the result that the prevailing level of delivered prices of $30 to $31 per ton c. & f. is being exceeded. Formosa received the first overseas exports of Canadian recovered sulphur at prices reported to be slightly below those of deliveries by Sulexco, hitherto the only supplier.

Recovered Sulphur

In Western Europe prices of indigenous supplies of recovered sulphur have remained unchanged since becoming firmer earlier this year. In West Germany prices in the Ruhr and at Hamburg of brimstone recovered at oil refineries and by Ruhrgas range from DM 118 to DM 125 per tonne plus turnover tax, landing and service charges.

In Belgium recovered sulphur is sold at BFrs. 1,300 to B.Frs. 1,350 per tonne and in Holland at Dfl. 99 to Dfl. 104. In France delivered prices to domestic consumers range from NF 130 to NF 140 per tonne. In Sweden recovered sulphur supplies of Svenska-Skifferolje—an increasing volume in liquid form—

is sold at Skr. 158 to SKr. 160 and imported Orkla sulphur is delivered at SKr. 158 per tonne.

Recovered sulphur in Western Canada remains nominally based on $23.50 per short ton *ex* plant. Delivered prices range widely in accordance with the incidence of freight charges but throughout Western Canada they are below notional competitive prices of U.S. or Mexican Frasch sulphur. This applies also to the mounting volume of exports to the North-Western and Pacific States and Alaska and most recently Taiwan, and as a result effective returns on an *ex* plant basis are substantially below the nominal quotation.

The recent agreement by the railway companies to reduce carriage rates from Alberta to Vancouver by 22.2% from ¢45 to ¢35 per 100lb. ($7.84 per ton) improves the export prospects for the mounting surplus. At current ocean freight to the Far East and India and loading charges at Vancouver ($1.37 per ton) Canadian producers can now expect to realise $10 to $13 per ton *ex* works.

Pyrites

The prices for European pyrites ruling in the first half of 1961 are to remain unchanged in the second half year. The price basis is provided by Spanish crude fines pyrites—Rio Tinto at 60s. and Tharsis at 61s. per tonne basis 48% S f.o.b. Other Spanish pyrites are priced correspondingly within narrow limits and Rio Tinto " confines " gravity concentrates are quoted at 50s. One or two small producers supplying lower grade material, mainly concentrates, are quoting up to 10s. per tonne below the general price level. Portuguese pyrites are based on 60s. per tonne f.o.b. Setubal and Cypriot and Norwegian pyrites are priced competitively. The average export value for Cypriot iron pyrites during January to February 1961 was £2 16s.

Residues values remain firm both on the Continent and in the U.K. Current quotations indicate 75s. per tonne for cupreous residues and 70s. per tonne for non-cupreous residues free Ruhr.

SUPPLY

U.S.A. Production of Frasch sulphur barely comes up to a monthly rate of 400,000 tons reflecting the lower level of domestic demand. Sulphuric acid output in the first quarter was 6% lower than in the same period of last year and non-acid sulphur use was also reduced. Exports during the first quarter 1961 totalled only 302,784 tons and were about 14.2% lower than in the same period of 1959. The Frasch sulphur producers' restrictions of output allow stocks to be maintained at a level of about 3.5 to 3.6 million tons. The volume of molten sulphur deliveries is mounting rapidly and already over 30% of domestic deliveries appear to be in this form.

Mexico. Frasch sulphur output remained restricted in recent months and despite the additional output of 2,500 tons per month from Texistipec dome, total production remained under 80,000 tons per month. Gulf Sulphur Company shipped 52,500 tons during the first four months of 1961, almost exclusively to export, and added about 12,500 tons to stocks which had been heavily depleted in 1960. Pan American Sulphur Company, having produced 286,531 tons during January to April, has had to withdraw 22,753 tons from stocks to meet sales commitments of which exports represented 301,620 tons. The start of liquid sulphur shipments by PASCO's new tanker *s.s. Etude* is an important landmark in the company's affairs.

Poland. Production of sulphur from native ores at Tarnobrzeg is reported to conform with plans and in the first six months of operation some 30,000 tonnes have been produced. The quality is said to be minimum 99.3% S. Current output is 10,000 tonnes per month.

During the first half of 1961 the Piaseczno mine produced about 350,000 tonnes of sulphur ore and the treatment plant is now utilising 75% of its production capacity.

Indonesia. Under the eight-year economic plan ending 1969 sulphur ore mining is to be intensified by opening up a number of existing mines. The deposits are almost exclusively of volcanic origin and are mostly small.

Yugoslavia. Brimstone has been placed on the list of commodities which may be now imported free of restrictions.

Recovered Sulphur

Spain. Recovered sulphur output in 1960 totalled 42,760 tonnes, virtually the same as in

1959. In addition to the established operations of Cia. Rio Tinto—employing the Orkla process—and Cia. Real Asturiana which recovers brimstone by the Asarco process, about 500 tonnes of brimstone was recovered by Calvo Sotelo from H_2S extracted from coal gas.

Canada. During the first quarter recovered sulphur output in Canada based on natural sour gas, oil and nickel refining totalled about 150,000 short tons. In Alberta recovery from natural gas yields at present about 40,000 short tons monthly, but output is rising progressively; in British Columbia the level of brimstone production is about 20% above last year's at a monthly rate of about 4,3000 short tons.

Whereas domestic deliveries and exports to the U.S.A. are advancing at only a modest rate from last year's level of 250,000 short tons the recent reduction of rail rates is expected to lead to rapidly mounting overseas exports. One 5,000 tons trial shipment to Formosa was made by International Sulphur Company in April and further deliveries by this company which ships sulphur recovered by Shell Oil of Canada are expected.

Significant additions to output are expected to result from the new operations of the Rimbey plant situated 50 miles south of Edmonton. Owned by some 25 companies and operated by British American Oil Company the plant has the largest gas processing capacity in Canada—326 million cu.ft. per day—but as most of the supplies which are situated in the Dick Lake and Homeglen/Rimbey fields yield low sulphurous gas, sulphur recovery capacity is only 233 tons daily.

The start of operations of International Nickel Company's new mine and plant at Thompson, Manitoba, represents a new source of recovered sulphur supplies. The smelter and refinery employs a process similar to that used at Port Colbourne since 1956 which includes the production of nickel sulphide matter from which brimstone is recoverable. To date the company has not indicated its plans for brimstone recovery.

U.S.A. Production of recovered sulphur from sour natural gas and at oil refineries is now at an annual rate of close on 800,000 tons and subject only to fluctuations in the tenor of gas supply and oil refining operations continue rising.

Shell Oil Company has announced the construction of a 130 ton per day recovery plant in the Bryans Hill gas field, Cass County, Texas, in conjunction with a 30 million cu. ft. per day gas treatment plant which is due on stream by the end of this year.

United Arab Republic. The General Petroleum Authority plans to build a £75 million petrochemical plant at Suez, based on the annual use of 120,000 tons of light gasoline fractions from nearby Government owned refineries. The products range will include recovered brimstone at an annual rate of 28,000 tonnes which is to be converted to sulphuric acid and CS_2.

Mexico. Output of recovered sulphur by Pemex totalled 23,720 tons during the first four months of this year, 17.6% less than in the same period of 1960. The lower level of output has been evident since late autumn 1960.

Lacq. Up to May production was being maintained at a level of 85,000 to 90,000 tonnes per month and is now rising towards full capacity of 110,000 to 120,000 tonnes per month. During the first five months of this year output amounted to 437,812 tonnes—an increase of 60.6% compared with the same period in 1960. Deliveries to home and export markets totalled 375,380 tonnes, 30.2% more than in the period January to May 1960. Stocks at Bayonne and Lacq appear to have risen 62,500 tonnes this year.

PYRITES

World trade in pyrites, although not expanding at as rapid a rate as one year ago, continues to grow. In 1960 world wide exports totalled 4.36 million tonnes pyrites, 21.2% more than in 1959 and 6% more than in 1958. Imports by European consumers accounted for 3.9 million tonnes pyrites, an increase of nearly 740,000 (23.3%) over 1959 and 500,000 tonnes (16.8%) more than in 1958.

West Germany. The world's largest pyrite importer, West Germany imported in the first quarter of this year 339,000 tonnes pyrites and, although 5% less than in the same period last year when it is believed consumers' stocks increased, the level of consumption and sulphuric

acid production has remained practically unchanged. Domestic production of 132,383 tonnes in the first quarter of this year is about 1½% lower than the average rate for 1959. A major pyrites acid project is being implemented by Sachtleben AG., Germany's principal pyrites producer. Based on Meggen concentrates, new sulphuric acid production of over 300,000 tonnes annually is foreseen, the bulk of which is destined for ammonium sulphate production by Ruhrstickstoff AG. under a long-term supply contract. This arrangement is reported to follow the decision to close a number of existing pyrites acid plants which hitherto supplied Ruhrstickstoff and which have become obsolete.

Southern Rhodesia. During 1960 the Iron Duke Mines produced 55,837 short tons pyrites compared with 51,114 short tons in 1959. The bulk was consumed for sulphuric acid manufacture at the Rhodia fertilizer plant near Salisbury.

Algeria. Production in 1960 rose steeply to 38,000 tonnes compared with 29,100 tonnes in 1959. Soc. des Mines de Fer de Miliana is the sole producer.

U.S.S.R. In recent months increasing numbers of offers of Russian pyrites have reached consumers and merchants in West Europe and in the U.K. Fines pyrites containing 47 to 47.5% S, 0.3 to 0.4% copper and flotation pyrites containing 45.5 to 46% S, 0.3 to 0.4% copper, both types with an arsenic content of under 0.05% As are being offered.

SULPHURIC ACID

Communist Countries' Activities

Poland. By-product sulphuric acid is playing an important part in Poland's plans to raise acid output to one million tonnes a year by 1965. A chemo-metallurgical combine is to be built under the five-year plan ending in 1965 based on increased lead-zinc mining activities at Trebinia and Olkusz in the Cracow province. Calcining of metal concentrates is to be integrated with large scale sulphuric acid production from SO_2 in smelter exit gases. A 90,000 t.p.a. acid plant is to be built in the Katovice province in conjunction with a similar project.

At the Tarnobrzeg sulphuric acid plant, built in connection with the sulphur ore mines, 5,000 tons of sulphuric acid is to be produced in June and according to the plan 50,000 tons will be produced by the end of the year. A phosphate fertilizer plant is under construction. This plant will be completed by the end of 1961 and will be working normally from the beginning of 1962.

Bulgaria. At Plovdiv a 60,000 t.p.a. (100% H_2SO_4) sulphuric acid plant is due to come on stream this year. Production will be based on SO_2 in zinc smelter gases. Plans provide for installed capacity in Bulgaria to be raised to 211,000 tonnes (100% H_2SO_4) by the end of this year and the Plovdiv plant will account for about two-thirds of the projected expansion.

U.S.S.R. Sulphuric acid production in the first quarter of this year totalled 1.4 million tonnes (100% H_2SO_4) an increase of 4% over the same period in 1960.

Freights

Large Continental Importers Shielded from Higher Rates

SO FAR, at least, the majority of users of sulphur and pyrites have escaped having to pay the very much higher freights which almost all other commodities have had to concede since late spring. On the main ocean routes rates for dry-cargo tramp ships of "conventional" size—up to 13,000 tons capacity—are at present at levels varying from one-third to nearly 90% above those prevailing during the worst of the slump. Yet freights on pyrites from the Mediterranean and Iberian Peninsula ports have hardly moved since mid-1959. During April/May a large number of bookings from Huelva and Setubal to Belgium were concluded at only 21s. 0d. a ton, the lowest since sterling was devalued in September 1949. If

loading and discharging costs are deducted the net freight to shipowners is even lower than that now current for the shorter haul from Bayonne to Antwerp or Rotterdam. Chartering from Huelva to France continues to absorb a large proportion of small carriers in the 1,000 to 3,000 tons class at around 28s. a ton for Bay ports and 31s. for the English Channel coast.

Low U.S. Rate

The rate for sulphur from the U.S. Gulf at 52s. 6d. a ton to East Coast U.K. appears low and does not reflect the considerable rise in the grain rate for a similar voyage. Although there are a limited number of ships structurally unsuitable for carrying grain or whose owners are unwilling to incur the heavy costs of the special fitments entailed, it does seem likely that British sulphur importers may have to pay more in the near future. For shipments to the Continent the rate has not been tested recently, but tankers are again making big inroads into the Atlantic grain trade and severely cutting rates, so that dry-cargo ships of equivalent size or larger than the smallest tankers capable of offering effective competition are excluded from the present wave of prosperity. While this situation continues Continental importers able to deal with 20,000 tons of sulphur at a time appear to be shielded from higher rates. An indication of the trend is provided by two "prompt" charterings in May from the Gulf to Santos, covering 22,000 tons. One ship obtained $8.50 a ton f.i.o. and the other $8.00, whereas in March this year owners were content with $5.50.

Freight Advantage for Bayonne

Although monthly sulphur shipments from Bayonne often attain 80,000 tons, few details of Lacq chartering programmes are available. One fixture which was reported covered 3,200 tons to Abadan at 90s. 0d. on f.i.o. terms. But freight details are not available of a 5,700 tons cargo to Cochin, nor of various 2,000 to 3,000-tonners which have sailed recently from Bayonne to Beyrouth, Alexandria, Arzeu, Jugoslavia and Lisbon, nor of the heavy shipments to North France, the United Kingdom and Scandinavia. On to-day's freights Bayonne appears to have a freight advantage over the Gulf of Mexico of some $1.70 for North-West Europe and at least $3.00 a ton for British ports. Shipments are, of course, often delivered to small ports not accessible to deep-sea vessels; and there is a considerable over-supply of coasters.

The following freight statistics are based on known charterings, save where recent reports are lacking. In such cases "notional" figures, calculated on freights paid for other commodities moving in the same direction, are inserted.

EXPORTING AREA	DESTINATION	FREIGHTS PER LONG TON (Month of March)		
		1961	1960	1959
U.S. Gulf/Mexico	United Kingdom[1]	52s. 6d.	47s. 6d.	45s. 0d.
,, ,, ,,	N.W. Europe[2]	$5.20	$4.90	$4.70
,, ,, ,,	India[3]	$12.50	$9.10	$8.90
,, ,, ,,	Australasia[3]	$10.85	$10.00	$9.80
,, ,, ,,	Brazil[4]	$8.50	$5.50	$4.75
Bayonne	N.W. Europe[4]	18s. 6d.	17s. 3d.	15s. 6d.
,,	United Kingdom[1]	29s. 9d.	32s. 6d.	25s. 6d.
Huelva	Antwerp[5]	21s. 0d.	25s. 9d.	23s. 0d.
Cyprus	Rotterdam[5]	27s. 0d.	26s. 0d.	25s. 0d.
,,	United Kingdom[6]	45s. 0d.	37s. 0d.	37. 6d.

KEY TO CHARTERING CONDITIONS:—

1 Cargo f.o.b. ship to pay current rate for discharging
2 Shipowner to pay 50 cents ton for loading and 40 cents discharge
3 Ship pays 50 cents ton loading and current rate discharging
4 Cargo f.i.o. (no charge to ship for loading/discharging)
5 Ship pays 2s. 6d. ton loading and 2s. 6d. ton discharge
6 Ship pays 2s. 6d. ton loading and current rate discharge

Recent Innovations by I.C.I. for Mining Anhydrite

New drilling carriage designed at Billingham

IN USE underground in the Billingham Anhydrite Mine of Imperial Chemical Industries Ltd. is the first of three "drilling carriages" designed and built by Materials Handling Section of the Engineering Design Department.

Similar in basic design to the swing-boom electricity rotary drill carriage which has been used successfully in the mine for the past three years for preparing shot holes for blasting, the drilling equipment consists of two electro-hydraulically operated drilling booms mounted on twin driving "turrets" and has been fabricated in the Billingham Workshops.

Short Chassis for Manoeuvrability

The equipment has been mounted on an A.E.C. "Mammoth Major" truck chassis fitted with a 150 horse-power oil engine. This chassis is basically the same as that used on existing drill carriage and for the 14-ton trucks in use underground in the mine for carrying anhydrite from the working faces to the plant, but has been shortened by about two feet to provide a carriage that is easy to manœuvre in restricted spaces underground.

Other new ideas incorporated are improved operational loading, accessibility of controls, positioning of electrical controls and other improvements of weight distribution and re-equipment to centralise these and make them more accessible. Overall weight of the carriage is 24 tons, including more than one and a quarter tons of lead ballast which is fitted at the front to compensate for the weight of the heavy drilling machinery at the back.

Independent Control

The twin drilling booms can be operated together or independently and can be controlled from a panel mounted on the left-hand side of the vehicle or remotely from a small control box operated by one man. Positioning and control of the booms of both drills can be affected in this way.

When in use the carriages will have to travel and operate on graded underground roads where the slops may be as much as one-in-four. Extensive tests have therefore been carried out on ramps to establish how the drilling equipment operates with the carriage tilted forwards, backwards or sideways.

To get these giant drill units to the mine, they have had to be completely stripped down into sub-assemblies, the parts carried underground and then the whole reassembled in the underground workshop.

It is expected that with the aid of this new equipment, mining capacity at Billingham, at present estimated at 1.3 million tons a year, will be increased.

Drilling carriage made in workshops of I.C.I. Billingham factory for use in anhydrite mine below factory. The carriage is seen on a test ramp adjusted to gradients similar to those encountered in the mine

Nichols-Freeman Roaster Converted into a Fluid-bed Roaster

Increases Mo och Domsjo's SO_2 Production

FACED with the necessity of greatly increasing its production of sulphur dioxide for its sulphite works at Alfredshem, Sweden, in the spring of 1958, Mo och Domsjo A.B., one of Sweden's leading pulp producers, examined the possibilities of increasing the output of its Nicholas-Freeman roaster. This plant was built during the years 1949-50 with the following specifications:—

Combustion capacity ...	70-ton pyrites/24 hr.
Normal SO_2 content ...	11% approx.
Furnace diameter (internal) ...	6380 mm.
Shaft area	32 m.^{2}
Combustion volume	283 m.^{3}

The plant had functioned satisfactorily from its start-up but capacity of the furnace could not be stepped up to cover the company's current demands for SO_2 gas. Mo och Domsjo, however, did not wish to build a roaster, because of the expense involved and the lack of space at the site. Conversion of the existing N.F. roaster into a roaster of the Badische Anilin-and-Soda-Fabrik-type (B.A.S.F. type) which is based on the fluidised-bed principle and is capable of coping with greater throughputs, offered a solution to the problem. The B.A.S.F. roaster also has the advantage of not requiring prior drying or screening of pyrites feed, the pyrites being fed direct from store to the roaster.

Increasing Capacity

A B.A.S.F.-type roaster of the same capacity as the N.F. roaster at Alfredsham would have the following dimensions:—

Furnace diameter	2420 mm.
Roasting area	4.6 m.^{2}
Combustion volume	33 m.^{3}

Thus the roaster would only be about one-seventh of the size of a N.F. roaster in cross-section area, and about one-eighth as large in combustion volume. Hence, in spite of rebuilding the lower part of a N.F. roaster cone to form a cylindrical bed section, capacity is increased several times over. The reconstruction, in fact, produces a B.A.S.F. roaster with a greatly enlarged furnace shaft, the only practical limitation in the increase in capacity by such a conversion being wholly dependent on other sections of the plant, particularly by the boiler and gas washing-cleaning plant in a B.A.S.F. roaster. As about one-half of the useful pyrites roasting heat is extracted from the bed, the conversion accomplished permits heat capacity of the roaster to be doubled, with retention of the original boiler.

Use of Existing Equipment

In the converted roaster the gas may be of a much higher temperature than with the N.F. type, and there is therefore a considerable increase in the SO_2 content of the gas produced, and moreover the existing steam boiler can be used up to double capacity without any significant increase of the amount of gas passing through the boiler. For the same reasons, the existing gas washing-cleaning equipment can be used within the framework of double capacity.

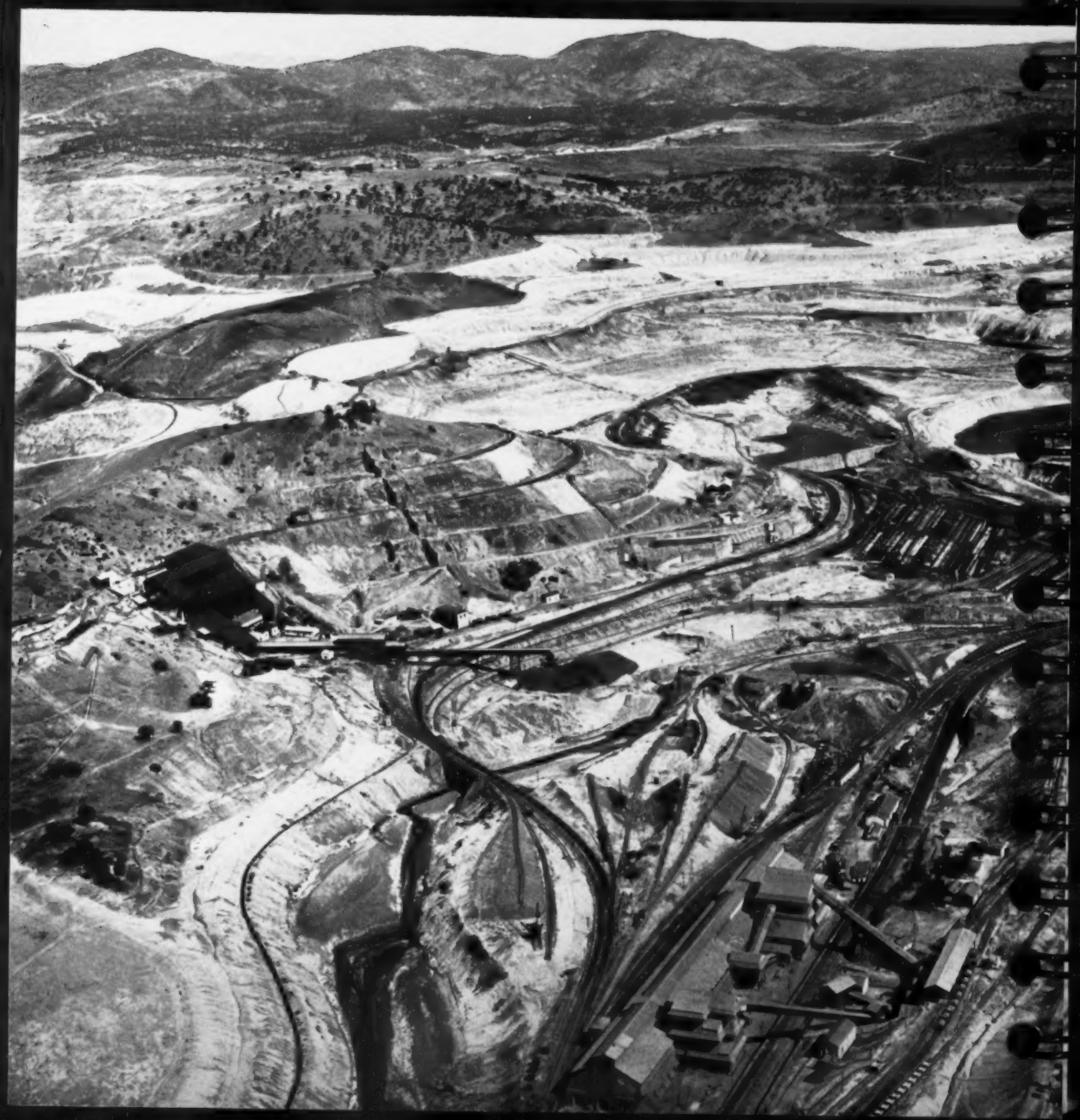
Roaster capacity required after conversion at Mo och Domsjo was about 100 to 120 tonnes pyrites per 24 hours, compared with 70 tonnes pyrites in the same period before reconstruction.

The company also wanted to roast — preferably in the same roaster — up to 25 tonnes elemental sulphur per 24 hours, which was being recovered in liquid form in the adjoining chemical recovery section of the modified sulphite pulp plant. The large furnace permits this, and elemental sulphur is burnt above the bed in the furnace shaft simultaneously with pyrites roasting in the bed.

Conversion of Mo och Domsjo Plant

In 1958 conversion of the N.F. roaster along the lines outlined above was decided upon. Aktiebolaget Celleco, who had delivered the N.F. roaster, carried out the work and the converted roaster was ready to start production at the beginning of April 1959.

Pyrites....



THE THARSIS SULPHUR AND COPPER CO. LTD.

COMPAÑIA ESPAÑOLA de MINAS de RIO TINTO S.A.

Pyrites is a stable, assured and competitive source of sulphur. The Rio Tinto and Tharsis mines in Spain have supplied pyrites for over eighty years. Their known reserves are unrivalled.

← Aerial view of the crushing plant, the pyrites concentrating plant and the copper cementation plant at the Rio Tinto Mines.

...Europe's principal source of sulphur

The bed section has the following dimensions—

Roasting area	7 m.²
Bed diameter (internal)	2000 mm.
Height of bed (internal)	3000 mm.

The bed is cooled to a suitable roasting temperature by steam generating tubes with a maximum working surface of 24m.², which according to the Noma system (patent applied for) are connected to the existing self-circulation steam boiler of the Foster Wheeler type. The installation was carried out by Jönköpings Mekaniska Verkstad, who delivered the original boiler. The new installation is believed to be the first of its kind, in which the cooling tubes in the bed of a B.A.S.F. roaster function according to the self-circulation principle.

Problem of Ash

As a result of the large shaft area above the fluo-solid bed, the rising stream of gas has such a low speed that a large part of the ash particles are not taken up in the gas but continuously fall back to the bed, forming a circulation between the bed and the lower part of the roaster shaft. Only particles of ash below 0.075 mm. in diameter are taken up in the gases passing to the steam boiler. Thus about 50% of the total amount of ash remains in the bed, and has to be removed to prevent the bed depth increasing. The continual tapping of the bed means, however, that the original coarse material which is usually added when a B.A.S.F. roaster using flotation pyrites is started up, is soon removed. The starting material in the bed is replaced during operation wholly by the fine particles of ash varying in diameter from 0.075 - 0.15 mm. that circulate between the bed and the lower part of the roaster shaft. The fine particle size of the bed makes it possible to operate with reduced bed heights than normally would occur during operation of a new B.A.S.F. roaster for flotation pyrites. Pressure under the fire bars decreases to an equivalent degree, and hence a considerable saving in running costs is obtained since the greater part of the consumption of energy in a B.A.S.F. roaster is by the fluidizing blower.

Pyrites residues removed from the bed have a high temperature (800 - 900°C). The residues are therefore cooled in a cooler of the paddle-screw type before entering the transporter.

Sulphur Burning

To burn elemental sulphur, the roaster was fitted with four nozzles in the cone of the burner. These are equipped with steam mantles to prevent the molten sulphur from hardening during its passage through the burners. Air and steam in arbitrary proportions can be used as the atomization agent. To effect a rapid change in capacity the sulphur burners have interchangeable nozzles with different diameters. In order to maintain the combustion temperature of the sulphur so that it is below the sintering temperature of the pyrites, water-sprays are fitted into the burner cone.

Start-up of a Converted Plant

At the start-up of the converted plant in April 1959, pyrites alone was burned but later pyrites and sulphur were burned simultaneously. Steady and regular operation became possible soon after a short trial period. The steam boiler with the new cooling tubes also functioned satisfactorily and it was found that the tubes did not require any more frequent cleaning than formerly with the N.F. roaster. There were, however, greater deposits of fine residues in the gas channel between the roaster and the boiler. The channel is blown clean every time the boiler is cleaned.

Atomization of sulphur in the burners is effected with air and the combustion temperature is regulated partly by the addition of "secondary" air above the bed, and partly by spraying water.

Good Combustion Efficiency

Despite the high content of sulphur dioxide (SO_2) the roaster showed good combustion efficiency. Sulphur content of the pyrites residues amounts to 0.6% S and the converted roaster, having only a very small number of moving parts, has been found to reduce maintenance costs considerably.

Operation Data

Formerly the roaster was operated on pyrites alone as follows:—

Pyrites	about 96 tons/24 hr.
Air	8500 Nm^3/hr
Bed temperature	about 860°C
Furnace temperature ...	not higher than bed temperature
Pressure under fire bars ...	not above 600 mm.v.p.
SO_2 content after boiler ...	about 13%

No secondary air was introduced and no water was sprayed in.

The converted roaster at Mo och Domsjo's plant is being operated according to the following operation data:—

Pyrites	72-80 ton pyrites/24 hr.
Sulphur	12 ton/24 hr.
Bed temperature	about 830°C
Furnace temperature (max.)	870 - 900°C
SO_2 content after boiler (equivalent to up to 14% in the furnace)	12 - 13%
Total amount of air	8300 Nm^3/hr.
"Secondary" air	1700 Nm^3/hr.
Water sprayed in	about 3 litres/min.
Pressure under fire bars ...	500 - 600 mm.v.p.

The maximum amount of elemental sulphur burnt to date in the roaster amounted to about 19 tons every 24 hours.

Data in this operation were as follows:—

Sulphur	19 tons/24 hr.
Pyrites	68 tons/24 hr.
Total air through fan	9000 Nm^3/hr.
"Secondary" air	2200 Nm^3/hr.
SO_2 content	13%
Bed temperature	740°C
Furnace temperature (max.) ...	930°C
Water sprayed in	3 litres/min.
Pressure under fire bars	500 mm.v.p.

It will be noted from the above that there is a low pressure under the fire bars, suggesting among others, a reduced consumption of energy.

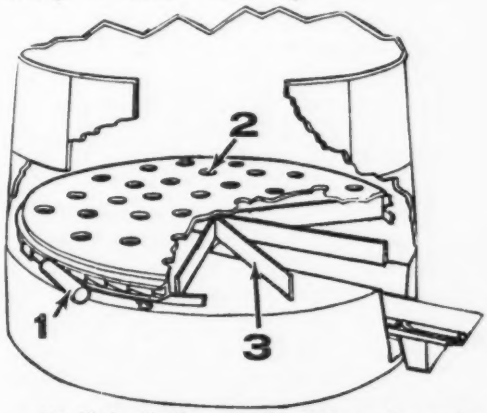
TROUBLE-FREE REMOVAL OF SOLIDS FROM STORAGE

REMOVING solids from storage can pose problems. **Jorgensen-Wellford, Memphis 7, Tennessee, U.S.A.,** after more than 30 years of experimenting, believe it has a trouble-free removal system that is moderate in cost, low in operation expense, is rugged and does not require a regular attendant.

Essential feature of the system is a revolving bottom with openings sized and spaced properly to handle the specific material that is stored. The material passing through these openings may be conveyed by various means to the ultimate destination.

About the periphery of the revolving bottom of the Jorgensen-Wellford system is a ratchet which is engaged to one or more hydraulic cylinders. With application of pressure to the cylinders the bottom rotates. (Material in the usual type of storage cannot do this as it is engaged by contact with the walls of the tank or building). As the bottom slides under the material it allows a portion of the stored material to drop through the openings. As this is not under pressure it is not difficult to move and it is swept by rotating fins projecting below the bottom into a conveyor.

Arching of the stored material does not occur. Also, because of its unique principle of operation, motion is very slow and power requirements are very low. Five standard sizes are available ranging from 15ft. 4in. diameter, 24ft. high and capacity of 4,400 cu. ft. to 29ft. 8in., 48ft. and 33,000 cu. ft. Horse-power varies from 2-3 to 7½-10. Special adaptations can be made to any existing storage facility. The suitable solid minerals for which the Jorgensen-Wellford removal system has been described include wood chips, grain, cotton seed, wood waste and minerals. It is considered that the system would offer marked advantages in storage of broken solid sulphur.



(1) Hydraulically-operated cylinder pushes against pins on outer edge of turn-table
(2) Turn-table feeds irregular-shaped solids through holes
(3) Beams supporting turn-table sweep solids into conveyor system in storage tin foil

Code 816 Catalyst for Contact H_2SO_4 Plants

SEVERAL U.S. plants have been using a new type of catalyst in contact sulphuric acid plants with, it is claimed, very successful results. The catalyst is in the form of pellets of vanadium pentoxide twice the size of the usual pellet and is known as code 816 catalyst. It has been developed by Von Bree Inc., consulting chemical engineers of Newark, Delaware, U.S.A. The large size pellets have mechanical properties equivalent to that of the usual vanadium catalyst pellet but the pellets do not spall in service, and can be used at a temperature of up to 700°C. Hence the new catalyst becomes commercially useful at temperatures where vanadium is not. Cost is about $20 per litre of finished pellets and the material is guaranteed to remain active for one year under normal operating conditions.

Von Bree catalyst 816 pellets have a kindling temperature of 370°C with feed gas of 9 to 10% SO_2 even at high overloads. This temperature compares with a kindling point of 430°C for vanadium. Also, because of high activity of the catalyst only one-quarter of the depth of catalyst charge is required at 450°C and only one-tenth of the depth at 550°C to achieve the same conversion as with a unit of vanadium.

Thin layers (one to two inches) placed over conventional catalyst increases conversion efficiency from normal 95% to 96 to 98% level at high production rates. Pressure drop is only 20% of that for the usual type vanadium catalyst per unit depth due to the large pellets size.

To decide how much catalyst to employ for a specified result, Von Bree Inc. calculates the activity of the usual vandium catalyst in each bed; plant operating data determined on the basis of these results are then used in the Von Bree kinetic equation to establish the predicted conversion possible for any feed gas composition, production rate, gas velocity, O_2/SO_2 ratio, and catalyst distribution or combination commonly encountered in constant sulphuric acid units, using Von Bree pellets.

Plant operating data required for calculation are the following:—

PRESENT OPERATION (preferably at highest rate)

(a) Converter diameter.
(b) Operating rate in tons 100% H_2SO_4 per day.
(c) Feed gas composition to the converter.
(d) Depth of existing vanadium catalyst beds.
(e) Pellet size in each bed.
(f) Conversion efficiency obtained.
(g) Amount of quench air used, and point of use.
(h) Gas temperature into and from each bed.
(i) Gas at exit of sulphur burner, or exit temperature.
(j) Temperature of air used for quenching.
(k) Pressure at inlet No. 1 bed, and pressure drop per bed.

PROPOSED OPERATION

(l) Operating rate.
(m) Gas composition desired.
(o) Maximum gas or temperature permitted at exit of sulphur burner.
(p) The lowest gas temperature in each bed that it is believed can be reached without air quench (with boiler by-passes closed tight).
(q) The approximate air or gas blower capacity in standard cubic feet per minute that appears possible under proposed conditions.

Catalyst 816 has been employed for over three years in several units. Sulphur sources have been brimstone (bright and dark), alkylation spent acid, hydrogen sulphide and pyrites. In two instances, the new type catalyst was used to prevent pollution as it promoted higher conversion efficiency. Based on raw material savings, Von Bree Inc., has been able to demonstrate net return of about 20% after taxes (U.S.A. basis) on the catalyst investment. It is suggested that the method permits control of air pollution at a profit without the necessity for additional equipment, or the formation of hard-to-sell by-products.

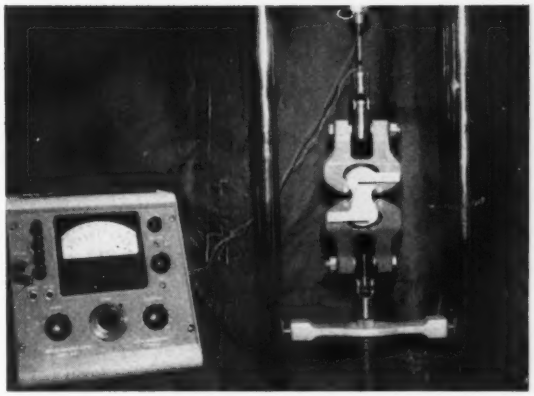
In two other situations where increased capacity was desired Catalyst 816 has proved to be very economical since it has permitted the higher production to be attained in the existing equipment. Higher annual returns have more than compensated for the higher cost of the catalyst.

Manufacture of the large-size pellet is complex to ensure the proper catalytic surface and from order to delivery in the U.S.A. may take up to three months.

It is suggested that the catalyst can improve conversion efficiency and production rate, or both at the same time. In some cases, however, employment of Catalyst 816 would not be economical when considered in relation to the value of the raw material sulphur source or of the increased production. It is not claimed that the new catalyst is a panacea for sulphuric acid plant problems, but it is useful if used wisely.

Determining the Mechanical Properties of Elemental Sulphur

Experimental study by Southwest Research Institute



Test facility for testing tension specimens

To determine the mechanical properties of elemental sulphur, John M. Dale, of the Department of Applied Mechanics, Southwest Research Institute, Texas, U.S.A., has undertaken an experimental study. Past uses of the material show that sulphur has reasonably good structural properties. For instance, sulphur has been used in machine shops to grout machines; in acid resistant mortars as additive in amounts up to 50%; in preparing bearing surfaces on the ends of cinder blocks so that these can be uniformly loaded when they are tested to destruction in compression testing machines. Solid sulphur, which can have a specific gravity as great as 2.07, has supported its own weight in vertical-walled vats without supporting sides to heights as great as 75 feet.

With the need to investigate new uses and applications for sulphur, it is necessary to know the properties of the material.

Experimental Investigations

The research programme undertaken by Southwest Research Institute has been divided into three separate parts:—

(a) Acquisition of representative test material
(b) Preparation of test specimens
(c) Physical testing of the specimens

Acquisition of Test Material

The greater part of sulphur in the United States is obtained using the Frasch process. In many of the working mines, the sulphur bearing formation is in association with varying amounts of petroleum. The sulphur produced from such mines is dark, almost brownish-green in colour. Other mines produce a standard bright grade which lies between the dark grade and the straw yellow colour of the laboratory material. Although of over 99% purity the dark grade is often cleansed to bring the colour characteristics up to that of the standard bright grade. Care has been taken therefore to secure test samples covering varying mine products and grades—or typical run-of-the-mine material.

Preparation and Testing of Specimens

Since there was no ASTM or other established test procedure for testing sulphur, Dale has studied various testing techniques to determine those most suitable for sulphur. Those that appeared to lend themselves most readily to the study of the mechanical properties of sulphur were those for testing concrete. Standard concrete specimen moulds for tension, compression and flexural specimens have therefore been used. As shrinkage of sulphur occurs when it solidifies or freezes rivers or dams have been placed in the specimen mould and excess risen material on top of the specimen removed after solidification. The molten sulphur cooled in the moulds in air at an ambient room temperature maintained between 60°F and 70°F.

Tension

For tension specimens special grips were obtained and adapted to a Dillon tensile testing machine. For increased sensitivity, a special strain gauge dynamometer link with a round centre section was made from aluminium and

placed in series with the grips. The strain gauges were attached on opposing sides of this link and measurements were read from an Ellis bridge amplifier.

Compression

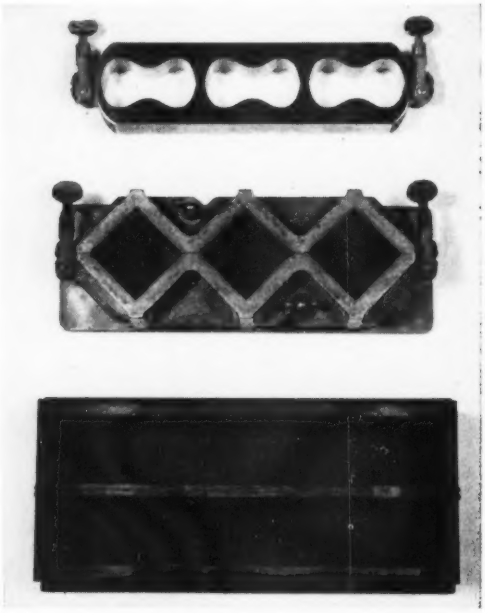
Specimens for compression tests were placed between two flat plates and tested in a 200,000lb.-capacity Baldwin universal hydraulic testing machine.

Flexion

For testing flexural specimens a special fixture was used to provide quarter point loading, the ends being simply supported. The Baldwin universal testing machine was also used in this test.

Results

In tension the specimens were found to break characteristically across the necked down or one-square-inch centre section. In compression the typical cup-cone type failures were encountered. In bending rather clean failures occurred at or near the centre of the span.



Specimen moulds for depicting tension, compression and flexure

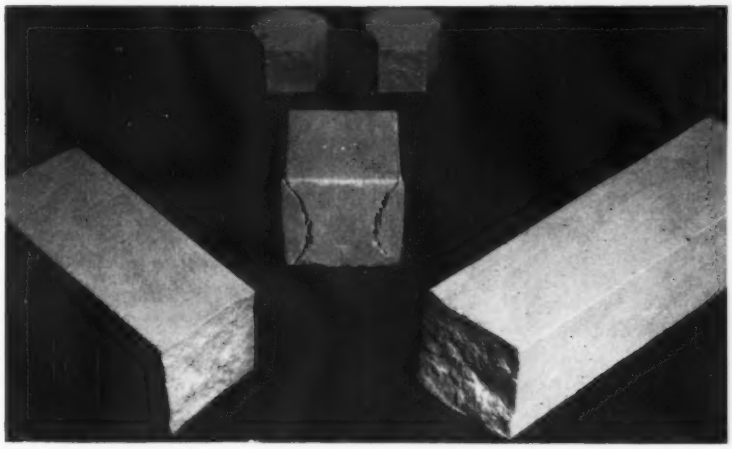
Discussion of Findings

Sulphur has a large number of allotropic forms in both liquid and solid strata. On freezing or solidification, the two most commonly found allotropic crystalline modifications are the rhombic and monoclinic systems. Dale has found that the monoclinic crystals are unstable at room temperature and within several hours after casting, the monoclinic crystals change to the rhombic system. The major change from the monoclinic system to the rhombic system was observed in the castings by their change in colour from light amber immediately after casting to the final characteristic colour in four to six hours after casting. The castings are noted as remaining sensitive to temperature, with further changes in temperature, causing internal cracking which can be heard by the human ear. Temperature control of the material from which specimens were prepared was difficult in melting sulphur in kettles in small electric ovens, followed by ladling into the moulds. No attempt has therefore been made to correlate strength characteristics with melting temperature. One interesting finding is that impurities present in dark and standard bright grades of sulphur appear to increase the strength of the sulphur. Another result is that mechanical properties of elemental sulphur show a tendency to increase with time —the final ultimate strength of elemental sulphur appears to occur at some time beyond the 28-day period.

Strength Greater than Concrete

Dale's results have been very encouraging as they have shown that elemental sulphur has tension and compression characteristics slightly greater than conventional concrete, which has an ultimate tensile strength of 150 p.s.i. and an ultimate compressive strength of 2,500 p.s.i. Laboratory test data reveal that various specimens had strengths from 50 to 100% greater than comparison specimens. The reason for this added strength is not known, but it must be considered significant in that determination of the conditions which created these added strengths might allow reproduction of these improved strengths.

Obviously in a study such as the above, where a small number of specimens only are prepared and tested, there are an extremely



Characteristic failures of test specimens
TOP, **tension**
CENTRE, **compression**
BOTTOM, **flexure**

large number of variations and influencing factors, and therefore the work must be considered only as a preliminary investigation. Nevertheless, these investigations have shown that elemental sulphur does have strength characteristics sufficient to consider it as a structural material. Therefore the Southwest Research Institute feels that by selecting a combination of conditions, it is possible that the structural properties of sulphur might be utilised to great advantage in new applications and used. Of the number of additional properties that the Institute would like to investigate are: hardness, impact strength, hand strength, plastic flow (creep under load), reinforced beam strength, water absorption and effects of coding rates. While practical support for this research to date has been obtained from Freeport Sulphur Company, Jefferson Lake Sulphur Company and Texas Gulf Sulphur Company, further sponsoring is required.

Potentialities

One of the considerations in mind at the start of the research was that the present large quantities of sulphur now being transported by barge and ship might possibly be made to transport themselves by way of taking molten sulphur as it is produced and casting it into the form of a ship or submarine which would be launched and towed to its destination by a small tug. This would eliminate the necessity for a large vessel and probably an empty return trip. Southwest Research Institute have already made some small submarine models in sulphur which have found to have approximately 10% positive bouyancy.

Molecular Sieves for Natural Gas Sweetening

PURIFICATION of natural gas by means of molecular sieves—synthetic zeolites—promises to develop into a large market. Produced by Linde Company and Dawson Chemical Company, two U.S. companies, the molecular sieve has advantages of simplicity of operation and reduction of pipeline corrosion, particularly for small on-site adsorption sweetening plants.

Several technical problems have hitherto prevented sieves from being used widely in gas cleaning. In liquid sweetening, however, the sieves have been very successful and of the total propane produced in the U.S. some 50% is now desulphurised from 400 to 500 p.p.m. down to 5 p.p.m. using molecular sieves. Recently Gulf Oil Company and Warren Petroleum Company announced successful development of an adsorption process for sweetening natural gasolene containing several thousand p.p.m. adsorbed sulphur.

In association with Maloney-Crawford Tank and Manufacturing Company, Linde has been carrying out tests at an experimental unit in West Texas, and a sweetening plant design which is stated to be both practical and economical has been evolved.

New Sulphuric Acid Plants Planned in Japan

JAPAN'S largest acid plant—600 tons daily capacity—is to be built for Dowa Mining Company. It will use the Chemico contact process.

At present the large acid plants in Japan have capacities of the order of 200-220 tons a day, although the two plants operated by Toja High Pressures Industries are believed to have capacities of 340 tons a day.

The acid produced by Dowa Mining will be supplied to the Yawata Iron and Steel Company and to Kyushu Chemical Company, a new company formed to produce ammonium sulphate.

Acid for TiO_2 Manufacture

A new contact-type sulphuric acid plant has been ordered by Ishihara Sangyo, K.K. of Osaka, Japan, from Chemiebau Dr. A. Zieren GmbH, for its Yokkaichi works. The new plant will have a capacity of 200 tons a day (monohydrate). The sulphur source material will be pyrites, which will be roasted in B.A.S.F. whirling bed roasters of the Raschka Heidelberg type. The sulphuric acid will be employed in titanium dioxide manufacture, which will be produced on a large scale.

In the construction of this new plant Chemiebau is associated with Niigata Engineering Company in Tokyo, which will erect the plant according to the design specifications from Raschka and Chemiebau. The plant is due to be completed this year.

In 1959, Chemiebau installed a sulphuric acid plant at Yokkaichi for Ishihara Sangyo, which has a capacity of 120 tons a day. The new plant, when completed, will raise the company's acid capacity to 545 tons a day.

Plant for Nihon Kokan

Another projected sulphuric acid plant for Japan is that of Nihon Kokan K.K., of 400 tons a day capacity. The company has a 120 tons a day dilute sulphuric acid plant, but it is expected that when the new projected plant is installed the old plant will cease to produce. The new facility is due to be completed by March 1962. Constructors are Lurgi GmbH of West Germany.

New Acid Plant for Furukawa Mining

At Ashio the Furukawa Mining Company Limited of Tokyo, Japan, is installing a new sulphuric acid plant which will more than double production capacity at this works. The new plant will employ the Monsanto process and the installation of this 210 tonnes per day unit will raise total sulphuric acid capacity at Ashio to 370 tonnes (100% H_2SO_4) per day. The project is scheduled to be completed by September 1961.

At the same time the company is increasing the smelter capacity by 1,000 tonnes of blister copper.

In 1960 Furukawa Mining produced some 60,000 tonnes of 98% and 45,000 tonnes of 50° Bé sulphuric acid.

Nihon Suiso's Plans for Surplus Acid

When present plans for production of 33,000 tonnes of urea are realised by Nihon Suiso, of Onahama, 39,000 tonnes a year of sulphuric acid, used previously in the manufacture of ammonium sulphate, will be surplus. Arrangements are being made, however, to supply Sakai Chemical Company with 24,000 tonnes of sulphuric acid for use in the company's 500 tons-a-month titanium dioxide plant. Waste sulphuric acid from this plant is to be sent back to Nihon Suiso for manufacture of calcium superphosphates and compound fertilizers.

Associated with Nihon Suiso will be another enterprise, Mitsubishi Metal and Smelting Company, which will construct at Onahama a copper and zinc smelter based on imported metal concentrates. Sulphuric acid recovered from smelter gases is expected to be supplied to Nihon Suiso and Sakai Chemical for use in a combine manufacturing fertilizer material from low cost ammonia.

Sulexco's Service and Facilities

S.S.H. Lorentzen **discharges her cargo of Sulexco sulphur in the Waalhaven, Rotterdam**

FORMED in 1958, the Sulphur Export Corporation (Sulexco) is a jointly-owned export sales organisation of the major four United States Frasch sulphur producers, Freeport Sulphur Company (37% share), Jefferson Lake Sulphur Company (18%), Texas Gulf Sulphur Company (37%) and Duval Sulphur and Potash Company (8%), who together mine, at present, more brimstone than all the other producers in the world combined. To publicise its export activities, Sulexco has produced an illustrated booklet "*This is Sulexco.*" The four companies between them operate 13 domes situated in Texas and Louisiana. These are reported to have an annual capacity of seven million tons of sulphur and total investment in mines and related facilities is about $200 million.

In addition to their long-standing sulphur activities the four member companies of Sulexco also all have considerable interests in the metal and chemical industries.

Duval Sulphur and Potash Company

Duval Sulphur has been a Frasch producer since 1928 and has exploited Orchard Dome, Texas, since 1938. The company is also a large producer of potash from extensive properties in the United States and has potash mining rights in three areas in Canada. It is also engaged in the mining and milling of copper and molybdenum.

Freeport Sulphur Company

Founded in 1912, Freeport Sulphur now operates five mines in Louisiana, including Grand Isle, the world's first off-shore sulphur mining plant which began operation in 1960*. Freeport also has interests in nickel, cobalt, oil, gas and potash.

Jefferson Lake Sulphur Company

The third largest sulphur producer in the United States, Jefferson Lake, now operates only one mine in Texas, Long Point, the company's two Starks, in Louisiana, and Clemens Dome, Texas, having been closed at the beginning of this year. The company also produces petrochemicals, including phenol, cresols and cresylic acid, and is establishing itself as a major producer of recovered sulphur from sour natural gas in Canada. It will soon be mining and milling asbestos from deposits in California.

Texas Gulf Sulphur Company

Formed in 1909, Texas Gulf is the world's largest sulphur producer and has mined sulphur in Texas since 1919. Boling dome, Newgulf, Texas, which began operation in 1929, is the largest and richest in the world with a total production to date of over 50 million tons and claimed to have ample reserves for many years to come. In addition the company operates sulphur domes at Moss Bluff, Spindletops and Fannet in Texas. Sulphur is also recovered from sour gas by the company in the U.S. and Canada; it has interests in deposits of lithium in North Carolina and base metal deposits in Canada. Large-scale production of potash from deposits in Utah is due to start in 1963.

Product Range

No two mines produce sulphur of exactly the same analysis. The result is that Sulexco is

* See Sulphur 29, May 1960, Page 15.

able to offer a wide range of grades, from a bright yellow, low-carbon grade for special chemical processes, through medium grades for general use, to a darker, lower-priced grade which is suitable for many acid plants.

Quality control is maintained at production, storage and shipping points. Each cargo is sampled as it is loaded and numerous analyses are taken and recorded.

To prevent contamination, storage vats are built on huge mats of pure sulphur.

Stocks and Shipping Facilities

Because of their overall size, the parent companies of Sulexco are able to maintain large reserves of material. Up to four million tons in the various grades are kept in above-ground stockpiles.

The three ports, Galveston and Beaumont in Texas, and Port Sulphur in Louisiana, can load up to six ocean-going vessels at once.

Frasch Mines Operated by Sulexco Members

Duval Sulphur & Potash Company	Orchard, Texas
Freeport Sulphur Company	Grand Isle, Louisiana (off-shore)
	Grand Ecaille, Louisiana
	Garden Island Bay, Louisiana
	Chacahoula, Louisiana
	Lake Pelto, Louisiana
Jefferson Lake Sulphur Company	Long Point, Texas
	Clemens, Texas
	Starks, Louisiana
Texas Gulf Sulphur Company	Boling, Texas
	Moss Bluff, Texas
	Spindletop, Texas
	Fannett, Texas

Modern equipment ensures that a full cargo can be loaded in 24 hours or less and the installation of additional liquid sulphur storage and loading facilities at Beaumont and Port Sulphur are designed to meet the mounting demand for sulphur delivered in this form. Houston, Texas and New Orleans are used for the shipment of bagged sulphur. Rail deliveries from the mines in solid and liquid form serve all three ports.

Mining Operations by A/S Stordo Kisgruber

One of the oldest pyrites producers in Norway, A/S Stordö Kisgruber of Litlabo was founded in 1907. The company put down a mine in a group of pyrites deposits. The main shaft is now 607 metres deep. By the end of 1960 the company had produced 6.6 million metric tons of crude ore, containing 22.5% sulphur, together with 0.4 million metric tons of waste. Total production of concentrates in the same period was 2.94 million metric tons. Annual production averages around 167,000 metric tons crude ore and 70,000 metric tons of concentrate. The concentrate produced by beneficiation contains 80% of the sulphur in the crude ore, together with iron and small quantities of other metals; the following is a representative analysis:—

	%		%
S ...	39.0	Na_2O ...	0.40
Fe ...	40.5	P_2O_5 ...	0.19
C ...	2.0	As ...	0.09
SiO_2 ...	10.5	TiO_2 ...	0.20
Al_2O_3 ...	2.6	Zn ...	0.025
CaO ...	0.60	Cu ...	0.025
MgO ...	0.55	Pb ...	0.020
MnO ...	0.50	Ni ...	0.013
K_2O ...	0.60	Se ...	Trace

Mining is carried out partly by shrinkage stoping and partly by sub-drift caving. Approximately 15% of the pre-crushed raw material is hand-picked into waste and ore. The rest of the crude ore is broken down to 30 mm. and is dressed by wet purification processes in in a jig plant in several stages with intermediate crushing of the middlings. Approximately 10% is washed by tabling and another 10% is floated. Preparation is difficult because of the presence of mineral constituents with low sulphur content consisting of finely disseminated pyrites in the gangue, as well as of heavy highly-ferrous waste minerals.

The shares of the company are owned by the Norwegian State, following the sequestration of German property after World War II. Prior to this Zellstoffwerke Waldhof, a leading German wood-pulp producer, held a major interest. Practically all of the company's output is exported, the most important market being West Germany. Its activities are integrated with those of other producers through the Norwegian Pyrites Producers' Association. Production in 1960 totalled 74,775 tonnes pyrites of about 39% S and 41% Fe representing an increase of 38% over the output in 1959 of 54,287 tonnes. In 1961 production of about 70,000 tonnes is foreseen.

Flotation Solves a Difficult Chalcopyrite-Pyrite Separation

Reagent Changes Overcome Metallurgical Problems

View of the open-air mine development at Buenavista Mine

FOLLOWING a successful drilling of a heavy iron gossan located about eight miles inland from Port of Bahia Honda, Province of Pinar Del Rio, Cuba, which is mined and shipped as high grade iron ore, Cia Minera Buenavista S.A. put down a further series of drill holes which revealed an underlying ore body of several millions of tons averaging 5.5% copper. The ore is massive sulphide (solid pyrite and chalcopyrite) assaying 48 to 50% sulphur and only 3% insoluble. The capping of iron oxide over the ore of a few feet thickness allows the deposit to be opencast mined.

Copper Content of Ore

The ore had been mined by Cia Minera Buenavista and shipped in 5,000-ton lots to Germany to Duisberger Kupperhütte AG. The mining company claims that it was unable to receive satisfactory terms from the German smelter company whose operations are normally geared to an ore containing up to 3% copper. The ore is stated to have a copper content of up to 7.0 to 8.0% copper. As the German company's terms for this high grade ore were unsatisfactory the Cubans decided to extract the copper from the ore, and produce a pyrite tailing suitable for sulphuric acid manufacture.

The ore has very little silica so that when the chalcopyrite is removed the tailing, which is almost pure pyrite, has a higher percentage of sulphur than before milling. The chalcopyrite is about 35% sulphur while pyrite will assay 51 or 52%. Concentrating the ore by flotation allows a copper concentrate to be produced which can be sold to a copper smelter and the tailing still used for its sulphur content.

Processing the Ore

Ore is delivered to the primary crushing plant and from there is carried by conveyor belts to the main crushed ore bin. An 8 by 7ft. ball mill in closed circuit with an 8 by 26ft. heavy duty rake classifier is used. A large conditioner, mechanically driven uniform flow pulp distributor, four 6-cell flotation machines, a 30ft. thickener, the six-disc, 8.5ft.-diameter filter, other minor flotation equipment, 18 rougher flotation cells and six cleaners are used. Middlings from the cleaners are pumped back to the ball mill. Average of 5,000 tons of pyrite is shipped to Germany monthly for its sulphur content which is used to make sulphuric acid. Copper concentrates, in lots of 5,000 or more tons, is shipped to Japan.

Metallurgical Problems

In copper flotation the standard pyrite depressant is sodium cyanide. Buenavista, however, did not wish to use cyanide because of possible pollution of water below the mill. Microscopic examination of the ore indicated an intergrowth of chalcopyrite and pyrite down to micron sizes. Grinding, therefore, would be required to at least 75 to 85% minus 200-mesh, and preferably even finer. The fresh ore was found to oxidize very rapidly and the pulp became markedly acidic while grinding and floating in a few minutes on laboratory scale.

Freshest ore from the deepest parts of the

open mine pit carried from 0.05 to 0.8% soluble copper as copper sulphate. By grinding the ore in the ball mill — with lime or without lime — the soluble copper so activated the pyrite that it could not be depressed without depressing the chalcopyrite simultaneously. Seven cleanings gave a 9% copper concentrate with very high tailings — 3% or more copper.

Washing out the soluble copper between coarse crushing plant and the ball mill was discarded as this would have necessitated washing a highly acidic and corrosive ore in expensive equipment made of stainless steel such as thickeners to handle the fines and slimes, and dewatering equipment to remove excess water out of the grinding and flotation circuits. Also a tin-can plant would have been needed to precipitate the copper in the wash water as cement copper. Cost of the plant would have been doubled and added to milling costs.

Solution by Reagent Changes

Called in as consultant, mining engineer William R. Wade, Marysville, Montana, solved Buenavista's metallurgical problems — by changing the reagents. To depress the pyrite sodium sulphite (Na_2SO_3) is used with lime instead of sodium cyanide. A larger ball mill than originally planned gives the necessary capacity for fine grinding in closed circuit with a large Duplex classifier.

Metallurgical Data

Product	Tonnage Daily	Copper %
Head	401	5.51 (0.06 soluble)
Concentrate ...	88	20.44
Tailing	313	1.29

Recovery, 81.73% of copper with ratio of concentration of 4.45 to 1.0

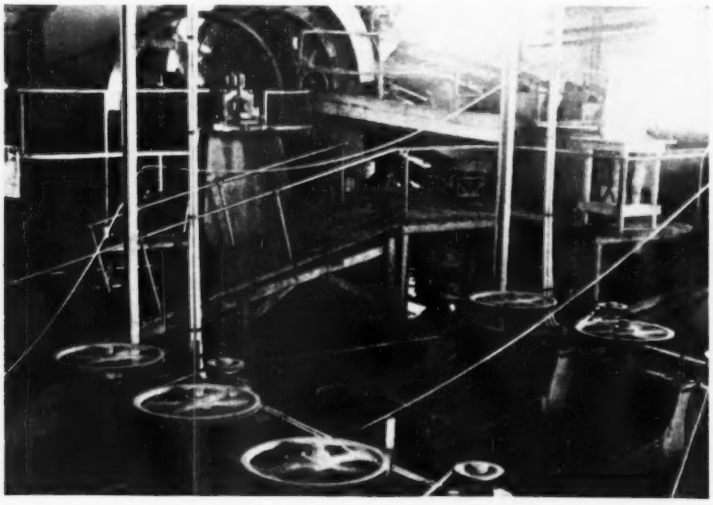
Reagent consumption in pounds per ton of ore milled: Lime 14.0; Na_2S 1.9; Na_2SO_3 1.9; Z5 0.1; Z6 0.2 and Dow 0.2.

Importance of pH

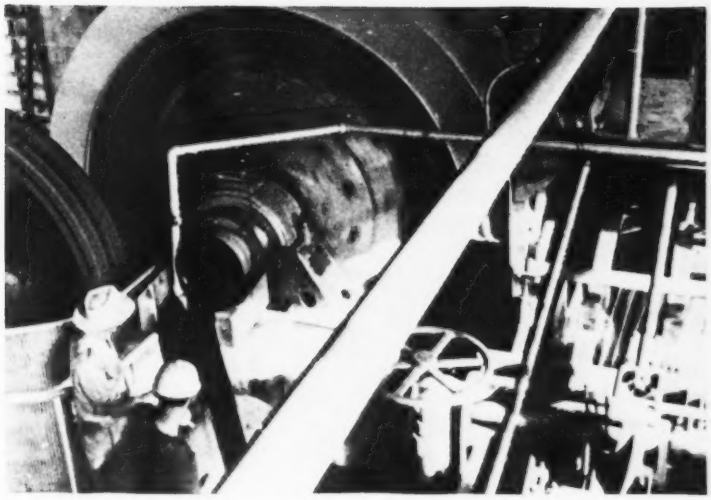
Accurate control of the acidic pulp formed during grinding is accomplished by maintaining a pH of 11.5 — the pH most advantageous for flotation. Samplers and pH indicators installed at the conditioner and cleaner flotation cells give a continuous pH reading. Feed rate of lime slurry to the circuit can be regulated by holding the pH at 11.5.

Depressing Soluble Copper

The greatest problem has been the soluble copper and the activity it sets up in the pyrite. The latter could only be depressed with such an excess of depressant that the copper was depressed also and went into the tailing with the pyrite. Adding sodium sulphide (Na_2S) to the ball mill scoop as a 20% solution solved this problem. Although in theory a little over 0.8lb. per pound of soluble copper is required; in practice double this amount—2lb. per pound of soluble copper, proved preferable. The extra Na_2S acts as a pyrite depressant. The Na_2S precipitates as black sulphide of copper which floats perfectly and rapidly in the mill.



Two banks of six rougher cells of which there are three banks



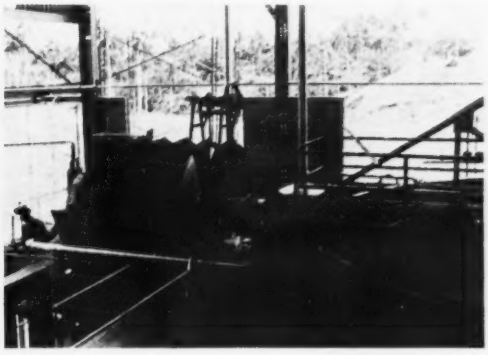
Ball mill, 8ft. by 6ft., discharging into a rake classifier 8ft. by 25ft.

Production Costs

The cost of additional and expensive capital plant and the cost of the extra continuous operating expense have been saved. The soluble copper in the ore now goes into the concentrate as a very high grade copper sulphide, so helping to raise the concentrate grade by a small percentage.

Operating Costs

About $0.08 worth of sodium sulphide is required to recover 1lb. of copper worth $0.30. As a bonus any excess sodium sulphide takes the place of sodium sulphite as a depressant for the pyrite. The sodium sulphite costs almost as much per lb. laid down in Cuba as does the sodium sulphide. Recovering the soluble copper by precipitation on tin-can scrap would take 2.5 or more lb. of tin-can scrap per pound of copper. This would cost $0.12 for the cans per pound of copper in Cuba, and takes no account of labour costs and capital to be written off during the time this oxidized or partly oxidized ore under the capping was milled. As the mine goes deeper, however, the soluble copper is decreasing and eventually will give no trouble.



Eimco Filter with six discs each 8ft. 6in. On the right is part of the Dorr thickener

Cuban Pyrites Exports

Main market for Cuba's pyrites at the present time is Western Germany. Up to 1955, Cuba exported sizeable amounts of pyrites to Italy and Sweden as well. In 1956, however, these markets ceased to import the ore from Cuba.

Imports to Western Germany from Cuba from 1955 are as follows:

1955	77,353	1958	36,081
1956	73,387	1959	24,943
1957	78,188	1960 Jan.-May	10,415

current events

UNITED KINGDOM

Stretford Plant for N.G.B.'s West Hartlepool Works

A Stretford liquid purification plant has been ordered by the Northern Gas Board for its West Hartlepool Works. The plant is being supplied by W. C. Holmes and Company Limited, of Turnbridge, and is designed to remove completely the hydrogen sulphide content of about 1% from 3 million cubic feet of coke-oven gas supplied from a nearby steel works. It is scheduled to be in operation in May 1962.

Since the coke-oven gas contains hydrogen cyanide the gas will receive prior washing with an alkaline solution containing an iron salt to remove the cyanide (as sodium ferrocyanide). This step is necessary to reduce operating costs by preventing the formation of sodium thiocyanate in the Stretford plant solutions. About one ton of sulphur a day—in the form of sulphur paste containing 40 to 45% water—will be recovered. N.G.B. will not process the sulphur further but will add the sulphur paste to spent iron oxide, low in sulphur content, from the plant's box purifiers. W. C. Holmes is one of the licensees appointed for the Stretford process*.

INDIA

New Sulphuric Acid Plants and Projects

Brimstone and contact plants with a daily capacity of 50 tonnes (100% H_2SO_4) were recently commissioned for Andhra Sugar Ltd. at Kovvur and for Andhra Fertilizers (Pvt.) Ltd., at Tadepalle. Both plants were designed and constructed by Simon-Carves Limited of Cheadle Heath, Cheshire.

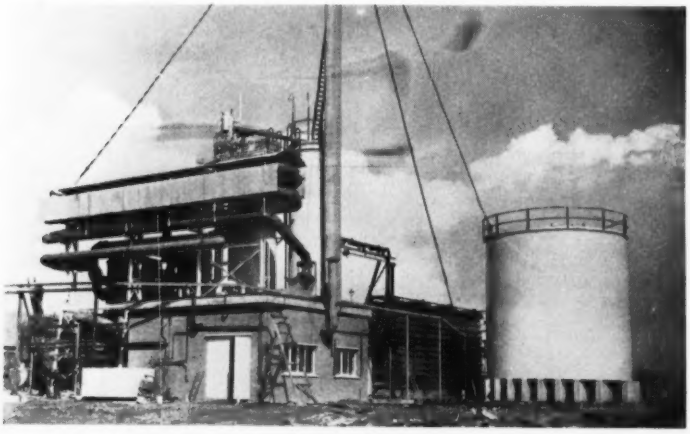
Three similar 50 tons per day sulphuric acid plants are at present on order from Simon Carves Limited for Blue Mountain Estates, the Tata Iron and Steel Company and Ralli and Company respectively.

PAKISTAN

Ammonium Sulphate Output at Daudkhel

Pakistan's first fertilizer plant at Daudkhel which was brought on stream in 1958 and is operated by the Government-owned Pakistan Industrial Development Corporation, is now working almost to capacity. Production in 1960 amounted to 44,711 tonnes, compared with 42,078 tonnes in the previous year and 20,140 tonnes in 1958. It is reported that plans are under consideration for doubling the present annual capacity to 100,000 tonnes.

The Daudkhel plant was built at a cost of Rs. 80 million by the Pakistan Industrial Development Corporation with American financial aid. Raw materials used in fertilizer manufacture are high sulphur coal utilized for hydrogen generation for ammonia synthesis, carbon dioxide and gypsum, found in deposits



The new 50 tons-a-day sulphuric acid unit of Farmers' Company Limited at Brigg, built by Simon Carves Limited. In May the share capital of this company was acquired by Associated Chemical Company Limited.

* See SULPHUR, December 1960, No. 31, April 1961, No. 33.

Converting the *s.s. Etude* at Bremen. The vessel is on charter to Pan American Sulphur Corporation (see under Mexico)

near the plant site. Lurgi gasifiers, a Lurgi oil wash plant, a Bamag final H_2S removal plant and an ammonia synthesis unit producing 40 tons of ammonia are included in the present installations.

Production of ammonia based on the high-sulphur content coal proved difficult in the early days of operation. The problems were solved with assistance from a Union Chimique Belge team of experts. Purification costs are reported to be high.

UNITED STATES

Liquid Sulphur Terminal at Boston

A new liquid sulphur storage facility is to be established at Boston, Mass., by Mystic Steamships Division of Eastern Gas and Fuel Associates. This terminal is part of Freeport Sulphur Company's extensive programme and is the third terminal established on the Western Seaboard.

At the end of April Mystic opened at Boston a new terminal for unloading, storing and transhipping bulk cargoes including ores and chemicals.

Shell Gas Processing and Sulphur Plant in Texas

Shell Oil Company, New York, N.Y., is to construct a multi-million dollar gas processing and sulphur plant in Bryans Hill gas field in Cass County, Texas. It is scheduled to be on stream by the end of 1961. The plant is designed to process 30 million cubic feet of gas a day and to produce daily 5,700 barrels of condensate, 18 million cubic feet of pipeline-quality residue gas and 130 long tons of sulphur from extracted hydrogen sulphide. Construction contract for the plant has been awarded to Brown and Root of Houston, and work will start on the plant this June. Hydrogen sulphide will be removed by the conventional amine process and the sulphur will be recovered in a two-stage Claus process plant. The new plant will be similar in design to the one just recently completed by Brown and Root for Tidewater Oil Company at New Hope, Texas.

The first producing well on the field was drilled last year. Since then Shell has drilled four more producing wells, and three more development wells are being drilled.

MEXICO

Liquid Sulphur Carrier for PASCO

Conversion of a T2-SE AC Tanker to a liquid sulphur carrier was recently completed at the Bremen shipyard of Bremen Vulkan Schiffbau and Maschinenfabrik. The vessel—*s.s. Etude*—which was originally built by Marine Ship Corporation in Sansalito, U.S.A., in 1944, is now owned by Lexington Ship Corporation, New York, from whom it is on

charter to the Pan American Sulphur Corporation (PASCO), of Houston, Texas. The vessel is 503 feet long, has a draft of 30 feet and a gross tonnage of 7,040 tons; its main propulsion is turbo-electrical (about 6,500 h.p.)

Conversion of the T-2 Tanker into a liquid sulphur carrier was carried out in the short space of 128 days and it is the third such vessel to be converted to carry liquid sulphur—the others are the *Marine Sulphur Queen* of the Texas Gulf Sulphur Company and the *Louisiana Queen* of the Freeport Sulphur Company.*

In effecting the conversion the following work was carried out. The deck was opened to insert tanks consisting of four compartments each insulated by means of Gerrix boards (of glass fibre); equipment fitted included pumps, pipeline for heating the tanks and the cargo lines.

Capacity of the sulphur compartments amounts to 315,528 cubic feet. When 98% full the tanks hold 15,461 long tons of molten sulphur. The sulphur is to be transported at a temperature of 135°C (275°F).

GUATEMALA

Sulphur Extraction But No Recovery

Central America's first refinery, a 4,000-barrel-per-day plant prefabricated in Texas and shipped to its jungle site near Puertos Barrios, Guatemala, is due on stream shortly. Lummus Company Inc. handled the project for Breaux Bridge Oil Refining Company Inc. of Houston, Texas.

The refinery incorporates a 2,600 bbl a day desulphurizer but this unit will be used solely to rid the liquid products of objectionable sulphur and is not a sulphur recovery unit. Sulphur, obtained in the form of hydrogen sulphide, will be burned as fuel for the boilers and furnaces of the refinery plant.

PERU

Acid Manufacture at Sybetra's Zinc Refinery

A 30,000 tonne zinc refinery to be built by Sociedad Nacional de Mineria y Petroles in Peru by Sybetra S.A. (Syndicat Belge d'Entreprises a l'Etranger) of Brussels, Belgium, will include by-product sulphuric acid facilities. The refinery will employ the Belgian patented Overpelt system (Belgian Patent No. 456,263, developed by the Cie d'Overpelt at Carphalie). In this process which is in use in many countries reduction of zinc concentrates is effected in horizontal retorts and will incorporate improvements.

Sulphurous gases from blende roasting pass to a contact plant for production of sulphuric acid.

It is estimated that when in full production, some 45,000 tonnes (100% H_2SO_4) by-product sulphuric acid will be manufactured.

SPAIN

S.A. Cros Increase H_2SO_4 Capacity

Production of sulphuric acid by S.A. Cros in 1960 rose by 6% to 380,000 tonnes (100% H_2SO_4). The company is the largest manufacturer of sulphuric acid and superphosphate in Spain, operating plants at 13 locations. In 1961 it is anticipated that acid production will rise by 97,000 tonnes following expansions at San Juan (Seville), San Jerimo (Seville), Valencia, San Carlos de la Rapita (Tarragona) and la Coruna. Production is also due to be increased at those plants which in 1960 worked at a reduced capacity.

The company also produces carbon disulphide and capacity is just over 10,000 tonnes, although production in 1960 was much below this level. At present the CS_2 output of S.A. Cros is used principally for rayon manufacture, in vegetable oil extraction, the rubber industry and production of carbon tetrachloride.

CZECHOSLAVAKIA

Using Waste Acid from TiO_2 Production

To improve the economics of manufacture of titanium white pigment from ilmenite by the sulphate method, waste sulphuric acid has to be utilized. In producing one ton of titanium white, seven to eight tons of diluted sulphuric acid containing about 20% of free acid and contaminated by sulphates of iron, manganese, titanium and other metals are obtained.

Hitherto waste acid was either utilized without any attempts at purifying it or it was regenerated or was neutralized yielding sulphate†.

Z. Cizinsky of the Moravian Chemical Works has worked out a method that makes

* SULPHUR No. 33, April 1961, Page 36.

† SULPHUR Special Issue 1960.

use of all constituents of the waste acid. The free acid is neutralized with ammonia, yielding Mohr's salt (ferrous ammonium sulphate) which precipitates on cooling and can be separated by centrifuging. More ammonia is then passed into the mother liquor until precipitation of iron and titanium hydroxides occurs.

Mohr's salt can be used to produce coleothar with low manganese content which can be used in the rubber industry or in preparing pure ferric oxide. Iron and titanium hydroxides furnish by calcination a brown organic pigment of high colouring and covering power. Ammonium sulphate formed by neutralizing the waste acid with ammonia can be used as fertilizer or for technical purposes. The heat of neutralization can be used for concentrating the ammonium sulphate solution.

The process can be modified according to conditions prevailing in the plant concerned and the quantities of final products required. Recovery of useful products contributes to the economic production of titanium oxide and solves the problem of effluent disposal.

U.S.S.R.

Paper Production Expansion Planned

Because of the backward state of the Russian paper industry a major programme for its expansion has been detailed. Over the next five years 32 paper and pulp mills are to be built, having an annual production capacity of 2.4 million tons of paper, 4.3 million tons of cardboard, 6.2 million tons of chemical pulp and one million tons of mechanical pulp.

British, American and Japanese companies are now negotiating for substantial contracts for paper and paper product mills to be built in Soviet Karelia, the Urals and Siberia, for it is doubtful whether the Russians have the know-how to produce up-to-date paper making plant and machinery.

Within the next three years technological improvements will allow Russia to build paper and pulp combines of 10,000 tons annual capacity, and cardboard plants of 280,000 tons annual capacity—70,000 tons within the next two years and 140,000 tons within 2½ years.

Investment in the U.S.S.R.'s paper industry in 1961 will total £80 million out of a total of planned investment £680 million for 1959-65. In 1960 construction plans for the industry were only fulfilled by 78.5% and targets have not been met in any years since 1951. Paper making is only 63% fulfilled, carboard 14%, cellulose 18%, viscose cellulose 4% and wood pulp 39%.

Within the period 1957-60 the average annual increase in paper production in Russia was only 123,000 tons compared with 394,000 tons in the U.S. At the present time the U.S.S.R. ranks fourth in world production of cellulose and fifth in paper and cardboard.

The present pulp and paper situation is of considerable interest to the U.S.S.R.'s sulphur industry. At present production of chemical pulp is about 3 million tonnes a year of which, it is estimated, one million tonnes is produced by the sulphite process, thereby consuming about 100,000 tonnes sulphur or sulphur in pyrites. It is not known how much of the planned raw capacity of 6.2 million tons chemical pulp will be based on the sulphite route, a conservative estimate would be one million tonnes but it could conceivably be as high as 2.5 to 3.0 million tonnes. Any new pulp plants will thus have to be planned with care if either the sulphuric acid industry or the pulp industry is not to be embarrassed by a shortage of sulphurous raw materials.

POLAND

Deterioration of Vanadium Catalyst in Sulphuric Acid Manufacture

Investigations into the deterioration of vanadium catalysts used in oxidising sulphur dioxide to sulphur trioxide by Polish chemical engineers W. Kuczynsk and J. Wesolovski have shown that loss of activity is due primarily to the formation on the surface of the catalyst of a film of iron sulphide. Activity of the catalyst can be appreciably increased, the Polish workers record, if the catalyst is exposed to the action of a mixture of hydrogen chloride and air, at temperatures near the upper limit of decomposition. This treatment results in a substantial increase in the surface area of the catalyst.

Greater activity has also been observed when the vanadium pentoxide catalyst used had not been exposed to any iron.

Sulphur Sales of Jefferson Lake Sulphur Co. Accounted for Nearly 70% of Income in 1960

" . . . the world does not have too much sulphur, and all producers . . . should realise the obligation to practice conservation and demand a price . . . which will result in profits . . . "

Eugene H. Walet, Jr.,
President,
Jefferson Lake Sulphur Company.

JEFFERSON LAKE SULPHUR COMPANY is moving towards more diversified fields of activities, but production and sale of sulphur will continue to be the largest single source of income, records Eugene H. Walet, Jr., president. The company's sulphur sales accounted for nearly 74% of income in 1960 and therefore the outlook for sulphur in the next few years and at long range is vitally important to the company.

During 1960, said Mr. Walet, world consumption of sulphur in all forms continued to increase, and amounted to about 17,250,000 long tons, of which elemental sulphur (from the Frasch process, sour gas, sour crude oil and volcanic deposits) constituted about 52%.

Indications of Higher Prices

" At year end," goes on Mr. Walet, " prices appeared to be firming in many of the world's markets, and indications point to higher prices, which are not only justifiable but are necessary for the relatively few companies which are engaged in large-scale mining and production of this basic material, as a primary business. It is these companies upon which industry and mankind depend for the sulphur during these current years and in the years ahead . . . It is estimated that within the next five years demand for and consumption of elemental sulphur will increase world-wide in excess of 3 million long tons, and consumption of all forms will approach 23 million long tons by 1965."

" Contrary to popular belief," Mr. Walet continues, " the world does not have too much sulphur, and all producers of this indispensable element should realise the obligation to practice conservation and demand a price for this product which will result in profits . . . the only way in which a strong and healthy industry can be created and sustained and which will enable the large expenditures required to explore for, discover, and thereafter make the large capital investments necessary to mine and produce sulphur."

Sulphur Production

Jefferson Lake Sulphur Company and its subsidiaries in 1960 produced 424,797 long tons, 4% more than in 1959. The Frasch plants produced 363,120 long tons, and 61,677 long tons was recovered from sour natural gas.

During 1960 two Frasch mines were closed down; the Clemens Dome, Texas, which was opened in 1937 and has produced about 3 million tons of long sulphur, and the Starks Dome in Louisiana, which opened in 1951 and has produced about 900,000 long tons of sulphur.

Frasch operations at the Long Point Dome, Texas, will become more economical and efficient because of the revision of certain agreements pertaining to sulphur and operating rights. Increasd sales are anticipated. During the year, exploration and development wells indicated additional proved reserves on this dome.

By the beginning of 1962 it is estimated that an additional 375,000 long tons will be available to the company when the East Calgary and Savanna Creek sulphur recovery plants start operation.

Canadian Subsidiaries

Jefferson Lake Asbestos Corporation. This company had no operating income in 1960 and has deferred all costs since its organisation in October 1959 until it begins actual mining and processing operations and sales of asbestos.

Recovery Plant Closed

In August 1960 the Manderson, Wyoming plant, which started in 1959 to produce elemental sulphur from concentrated hydrogen sulphide, was closed down, having produced about 90,000 long tons of high grade sulphur. The Mobil Oil Company's adjacent sour gas processing plant, which supplied the hydrogen sulphide, closed down because of operating losses due to greatly reduced volumes of sour natural gas from the Manderson field.

Trans-Jeff Chemical Corporation. In January 1960 the Trans-Jeff Chemical Corporation was formed to extract sulphur from sour gas. Shareholders are Jefferson Lake and Transcontinental Gas Pipe Line Corporation, each having an investment of $25,000 and owning 50%, or 50,000 shares, of the issued and outstanding common stock. In July 1960 Jefferson Lake and Transcontinental each loaned Trans-Jeff $100,000 at 6% per annum. Transcontinental is the operator and Jefferson sells the sulphur.

Oil and Gas

The oil and gas division of Jefferson Lake has interests in 50 oil wells and 25 gas wells in Texas and Louisiana. At the end of the year net reserves had been increased to about 2 million barrels of oil and 23 million cu. ft. of gas. The division drilled and participated in the drilling of five wells, of which two were producers.

Finances

Consolidated net sales and operating revenues for Jefferson Lake and its subsidiaries, Jefferson Lake Petrochemicals of Canada Limited (69% owned) and Jefferson Lake Asbestos Corporation (100% owned at year end), in 1960 was $10,165,676 ($9,605,475). Net income from actual operation was $1,539,355 before depreciation, depletion and amortization of $897,408 ($1,338,741) interest of $365,111 on long term debt, charge off of intangible drilling and dry hole oil and gas well costs of $63,593, and exchange loss of $31,773 due to the decrease in the exchange rate between Canadian and U.S. dollar, making total charges of $1,357,885.

Net sales and revenues of the parent company were $9,727,405 and net profit after charges was $169,641. For Jefferson Lake Petrochemicals of Canada, net sales were $482,541 and net profit was $86,311.

Earnings and Profits Down in First Quarter 1961, for Jefferson Lake Sulphur Co. and Subsidiaries

In the first quarter ended 31 March 1961 Jefferson Lake and its subsidiaries Jefferson Lake Petrochemicals of Canada Limited, and Jefferson Lake Asbestos Corporation, had earnings amounting to $173,762 after depreciation, depletion and amortization charges totalling $179,844. After payment of interest of $83,338 and "shut down" expenses of $80,402 for Clemens and Starks Domes and the Manderson Sulphur Plants, a loss of $18,067 is recorded. In the same period 1960, earnings and profits amounted to $86,121.

Sulphur Shipments in 1961

During the first quarter of 1961 shipments of sulphur from the company's Gulf coast mines were 31% less than in the corresponding period of 1960. Shipments into Alaska, British Colombia, Washington, and California from the Peace River plant of Jefferson Lake Petrochemicals increased 63%. Of the Gulf Coast shipments, 65% were from stock remaining at the Clemens and Starks Domes.

The average price received for sulphur, f.o.b. Gulf Coast Mines, during the first quarter was $1.11 less per long ton than that received in the same quarter of 1960.

Financing for the $13 million required for construction of the gas processing and sulphur plants and facilities at the East Calgary field of Petrogas Processing Limited, has been completed. Similarly, the Candian company has completed arrangements for the $5 million required to construct the Savanna Creek sulphur plant.

Sulphur Output of Jefferson Lake Petrochemicals of Canada Now Expanding Rapidly

PRODUCTION of sulphur in 1960 by Jefferson Lake Petrochemicals of Canada Limited amounted to 54,483 long tons (47,718 long tons in 1958). Sales totalled 32,398 long tons, compared with 40,372 long tons in 1959. At the year end stocks totalled 88,802 long tons. Net sales were $482,541, and after depreciation charges of $99,620 net profit was $86,311. This compares with a profit of $15,613 after depreciation charges of $222,600 in 1959.

Operations of the Peace River plant provided the total income in 1960.

Sulphur Price

The price received for sulphur, f.o.b. Peace River, during 1960 was $2.07 less than in the previous year, reflecting, according to the president, Eugene H. Walet Jr., and vice-president Harold W. Manley, the continued attrition of sulphur prices throughout the world during the first nine months of 1960.

Peace River Project

In the Peace River-Fort St. John area, drilling and exploration has been accelerated, and the Westcoast Transmission Company has completed a 26-mile extension of its Fort St. John gathering system, which will increase deliveries of raw gas to the processing plant and raise the volume of concentrated hydrogen sulphide supplied to Jefferson Lake's Peace River sulphur plant.

Formation of Petrogas

Progress was made in 1960 towards development of the East Calgary and Savanna Creek projects. Agreements on terms to finance the East Calgary project have been completed through a new corporation, Petrogas Processing Limited, in which Jefferson Lake Petrochemicals and Mobil Oil of Canada Limited are the major shareholders, each with 313,583 one dollar shares out of a total of one million. The plant

complex has been designed by the Ralph M. Parsons Company of Canada Limited, and construction of this plant and facilities, as well as that at Savanna Creek, is under way.* At East Calgary some 150 million cu. ft. a day of raw gas will be processed to produce 100 million cu. ft. a day of dry pipeline gas, about 2,000 barrels a day of liquid products, and 860 long tons of elemental sulphur*. Completion of the plant, facilities and gas gathering system is scheduled for December 1961, and operations are expected to begin before the end of the year.

The Savanna Creek sulphur reduction plant, situated at Coleman, Alberta, will also be built by Ralph M. Parsons Company. It will have a capacity of 375 long tons of sulphur a day and will be supplied with concentrated hydrogen sulphide from the gas processing plant adjacent, which will be erected by the Saratoga Processing Company Limited, a subsidiary of Westcoast Transmission Company Limited. Completion of the plant and starting of operations are expected by the end of the year.

Financial Arrangements

Net proceeds to be received by Jefferson Lake Petrochemicals from the sale of debentures and warrants will be used for construction of the sulphur recovery plant at Coleman, estimated to cost approximately $1,300,000 to repay short term bank loans of $425,000 to defray the company's projected drilling programme for additional gas wells in East Calgary, estimated at $300,000, acquisition of interests and for other opportunities beneficial to the company.

Rio Tinto's Increased Investment Income

" Diversification has been both geographical and functional . . . Our interests are not solely confined to mining and our policy is to enter into industrial activities and investments where they are logical developments of our mining operations, or where our expertise can be profitably employed." **Mr. Val Duncan, Managing Director, Rio Tinto Company Limited.**

INTERESTS of the Rio Tinto Company Limited, in a wide range of ores, which include pyrites and uranium, were indicated by the managing director, Mr. Val Duncan, when he reviewed the company's operations in 1960. He hoped that the U.K. would take its rightful place in the development of the natural resources of the world in general, and the Commonwealth in particular.

Spain

Gross profit of Compania Espanola de Minas de Rio Tinto S.A. for 1960 is expected to exceed the 1959 profit of pesetas 110,645,000 (660,000). This is due to increased exports of pyrites, and higher domestic sales of pyrites and to the operation of the new sulphuric acid plant, which recovers sulphur in the smelter waste gases. Construction was completed in three years, and the plant began operating in August. It is now producing acid at the scheduled rate of 65,000 tons a year.

During the year Rio Tinto received the final instalment in respect of the purchase price of the two-third interest in the mines and plants in Spain.

U.S.A.

Pyrites Company Inc., of Wilmington, had " quite a good year," but the prospects for 1961 are poor because this market for iron sinter will cease once the present stocks for raw material have been exhausted.

Canada

Through Tinto Holdings Limited the wholly-owner Rio Tinto Canadian subsidiary acquired an 84% interest in Rio Tinto Canada. This move has substantially increased the beneficial interests in Rio Algom Mines Limited (to 37%), the company formed in 1960 to merge into one company all uranium companies in Canada under Rio Tinto management.

Rio Algom

Striking reductions of working costs and increases in efficiency have been made by Rio Algom and have been reflected in further considerable reductions of the company's bonded indebtedness which should shortly be cleared entirely.

Since Eldorado‡ had agreed to existing contracts being extended, Rio Algom will be in operation on its present contracts until around the end of 1965, when only one of the company's uranium mines is scheduled to be operating.

Australia

Another successful year by Mary Kathleen Uranium Limited, Queensland, is reported. Production of uranium oxide was well maintained and mill efficiency has been improved by use of an electronic sorter. Material containing 1,637,000 tons of uranium oxide was mined during the year, but reserves were reduced by only 167,000 tons due to the discovery of additional ore.

Africa

Since the future of the Central African Federation is clouded by uncertainty, it is expected to affect not only operations of Rio Tinto's Rhodesian companies but also the future of Rio Tinto's large investment in the Northern Rhodesian Copperbelt.

Oil

Rio Tinto has agreed to dispose of the bulk of its interests in oil and gas to the British Petroleum Company Limited, for a consideration of 3 million BP shares.

Finances

Net profit in 1960 for the Rio Tinto Group was £2,042,000 as against £1,847,000 in the previous year, and net profit for the parent company was £886,000 in 1959.

‡ Eldorado Mining and Refining Company, the Government refinery of uranium concentrate.

† See SULPHUR No. 33, April 1961, Pages 35 and 44.

Increased Pyrites Shipments from Tharsis Sulphur and Copper Co. in 1960

"Under the onslaught of the internecine sulphur competition pyrites producers have been required to defend their market by successive reduction in price . . . These are signs that this situation is being remedied."
W. P. Rutherford, Chairman, Tharsis Sulphur and Copper Company.

IN 1960 shipments of pyrites by Tharsis Sulphur and Copper Company totalled 708,884 tons, an increase of 71,101 tons over the previous year. Mr. W. P. Rutherford, chairman, considered this increase fairly satisfactory in view of the rather dull market. In addition to the company's shipments of pyrites, deliveries were also made of residues of high quality from old heaps at Calanas Mine.

Markets and Prices

Mr. Rutherford emphasises in his report that "pyrites hardly ranks as a competitor to sulphur, although the reverse is certainly the case." Due to competition from sulphur, pyrites producers have had to defend their market by successive reductions of price. Sulphur, which unlike pyrites has no defence from by-products, he points out, has suffered greatly from price reductions, lowering the price to a level very substantially below its former rightful standard. "There are signs that this situation is being remedied. It is hoped that the recent upward movement of sulphur prices will continue until the price reaches its proper level. It is not to be expected, remarks Mr. Rutherford, that works that have left pyrites and expensively converted to sulphur-burning will reverse the process. Although forced to fall in line with price reductions for sulphur, pyrites cannot follow the upward trend so long as the sulphuric acid makers continue to replace their pyrites burning plant by the less costly sulphur-burning equipment. "An end to the recent price war will be very welcome."

Demand for sulphur material is fairly active generally. In the domestic market in Spain the price remains much too low. Mr. Rutherford considered that "this continued control is unexpected after the financial reforms of 1959, and puts too heavy a burden on mines."

The fertilizer season in Spain was poor in 1960 due to climatic conditions, but the Spanish chemical trade is expansionist.

Mines and Port

At Tharsis, overburden in the opencasts is being removed by diggers loading into dumpers. This method is efficient but interruptions are caused by rainy periods, and in drought of summer the dust proves a handicap. The progressive silting of the Port of Huelva has necessitated dredging operations. It is hoped that ultimately the river and bar will be brought up to the full requirements of modern ports. Last year the company loaded 187 ships.

Finances

Net profit of £196,705 was higher in 1960 by £40,818, due to heavier shipments of pyrites, and particularly to a sharp increase in production of cupreous mineral. Shipments of calcined residues were over 50% higher than in 1959.

The sale price of pyrites remained steady throughout the year, but was lower than in 1959 following the reduction in the last quarter of 1959. Mining costs have been maintained at the same level for the third successive year.

The sum of £151,874 has been written off property and plant and £100,000 has been allocated to general reserves.

Sales and Profits for F. W. Berk and Co., the Highest Ever

HIGHEST ever sales and profits are reported by F. W. Berk and Company Limited, of London, for the year ended 31st December 1961. Group sales were £9,024,200, an increase of 8% on the previous year and gross profits £684,787. A dividend of 6d. for each 5s. share is recommended and together with the interim dividend of 2¼d. paid on 3 October 1960 this will absorb £151,594 for the year. After deducting tax, and dividends on ordinary and preference shares, the profit retained in the company is £177,786, compared with £154,692 for 1959.

After deducting transfer to reserves and adding the balance of £346,162 brought forward from the previous year, the balance carried forward in the consolidated balance sheet is £373,948.

The increased annual profits are attributed largely to the broadening of the company's activities. Associated companies have all shown improved results. Abbey Chemicals have paid their first dividend and the profits of Deterex Limited continue to increase.

Gross profits of the group (before taxation) have been steadily rising over the past years:—

1956	...	...	...	£251,913
1957	...	...	...	£358,884
1958	...	...	...	£393,683
1959	...	...	...	£524,583
1960	...	...	...	£684,787

Spencer, Chapman and Messel Limited, which owns Theodore St. Just, has paid a dividend for the six months to 30 September 1960. A 25% interest has been acquired in Bromine Compounds Limited, a new company formed in conjunction with the Dead Sea Works Limited, and American interests.

During the year the company commissioned at Stratford, London, E.15, a 1,000-ton liquid sulphur tank to facilitate handling the despatch of liquid sulphur by tanker*.

* SULPHUR No. 33, April 1961, Page 11.

50% Increase in Sulphur Production by Duval Sulphur and Potash in 1960

SULPHUR sales (by volume) increased in 1960 but a decline in average unit price held sulphur revenues to the 1959 level, W. P. Morris, president of Duval Sulphur and Potash Company, reports in his annual review.

Operations at the company's Orchard Dome sulphur property in Fort Bend County, Texas, continued uninterrupted during 1960. Production from the deep mining area, started in 1959, contributed materially to the increase (50%) in sulphur production last year.

Improvements Made

Additonal improvements have been made in the water-heating plant during the year under review, in a continuing effort to increase efficiency and effect reductions in operating costs. The sulphur storage and loading system has been reorganized to minimize labour costs in loading operations. To provide improved working conditions in the producing area during rainy periods, extra control measures have been taken.

Research and experimental work is in progress on sulphur filtering media and boiler feed water treatment in an effort to reduce costs in these two phases of sulphur operation.

Sales in 1960

With world-wide sulphur consumption at record levels in 1960, Duval Sulphur and Potash Company experienced an increase in its sales for the second consecutive year. Greater production from domestic and foreign sources, however, kept the sulphur market highly competitive. Recently, Mr. Morris noted, there had been a strengthening of the price in the export market.

Other Activities

Productioi at the company's potash mines near Carlsbad, New Mexico, increased by 3%, while a substantial growth in demand for the product in the U.S. increased the price as from 1 July 1960, restoring it to the level ruling in 1957.

Sales of copper and molybdenum increased and essentially all of the 1960 production of both metals was sold.

Finances

Gross revenues of $31.2 million in 1960 were the highest in Duval Sulphur and Potash Company's history, exceeding 1959 revenues by $12.2 million. The greater part of the increase came from the increased sales of copper and molybdenum. Net income was $4.6 million as against $2.3 million. Earnings per share were $3.53 compared with the previous year's $1.81, and dividends of $1.25 per share were paid. Capital expenditure at $2.25 million is down slightly from that of 1959 ($2.27 million).

Recent Take-over Bids for Dominion Fertilizer Company

OFFERS to take over Dominion Fertilizer Company Limited have been made recently by two other New Zealand companies.

Dominion Fertilizer operates a 120,000 tons a year superphosphate works and integrated sulphuric acid plant at Ravensbourne, Dunedin, and has a capital of £360,839. The two companies concerned were Kempthorne, Prosser and Company's New Zealand Drug Company Limited, and Wright, Stephenson and Company Limited, which was recently acquired by New Zealand Farmers Fertilizer Company.

Terms of Bid

The bid by Kempthorne Prosser was based on three of its £2 ordinary shares for every five of Dominion Fertilizer's shares, equal to £1,179,946 on present market values. Wright Stephenson's competing offer at first of £NZ1,262,926 of 5 Wright Stephenson £1 ordinary shares for 4 Dominion Fertilizer shares was later raised to a 7 for 5 equal to £NZ1,414,493.

Directors Disagree

The directors of Dominion Fertilizer so far have been unable to agree on a recommendation to shareholders. In the meantime, the New Zealand Government is to reconsider the request of a group of Canterbury and Otago branches of the Federated Farmers for permission, previously refused, to use £1 million of the funds of the Meat Producers Board for their £1.5 million take-over bid for Dominion Fertilizer. Wright Stephenson has indicated that if it was successful it would invite Federated Farmers to be represented on the board.

N.B. There are, at present in New Zealand, six private fertilizer companies, including Dominion Fertilizer, operating superphosphate works and three farmers' co-operative societies' superphosphate works.

STATISTICAL APPENDIX

UNITED STATES

SULPHUR EXPORTS
(Long Tons)

		PRODUCTION		STOCKS		EXPORTS	IMPORTS*
		Frasch	Recovered	Frasch	Recovered		
1959							
	June	346,887	58,679	4,078,807	162,911	125,337	92,568
	July	318,192	53,543	4,008,018	159,944	170,696	61,112
	August	368,561	54,169	3,875,792	156,342	178,010	51,596
	September	399,157	52,050	3,814,932	154,211	146,486	†
	October	483,086	49,950	3,899,128	145,185	125,474	39,332
	November	408,481	51,623	3,833,537	142,157	141,442	36,080
	December	411,531	59,455	3,809,708	140,246	160,558	35,188
1960							
	January	388,630	54,907	3,845,754	133,860	116,523	85,170
	February	366,357	57,546	3,811,384	131,466	108,158	45,992
	March	436,530	62,285	3,810,348	123,013	128,118	53,561
	April	469,002	63,933	3,765,767	114,830	175,212	79,694
	May	420,290	59,125	3,719,898	111,921	160,335	84,880
	June	393,931	60,072	3,669,184	110,119	168,964	64,891
	July	419,891	63,720	3,734,422	108,653	107,305	48,035
	August	453,555	61,185	3,718,759	103,613	208,663	82,254
	September	372,514	58,736	3,655,347	103,891	165,063	30,891
	October	389,930	63,653	3,560,691	108,595	179,698	45,823
	November	399,624	62,778	3,553,311	110,496	151,169	66,803
	December	477,089	64,265	3,668,556	109,467	104,997	53,621
1961							
	January	400,433	66,343	3,697,709	110,361	95,358	70,308
	February	357,078	61,625	3,703,228	111,050	117,853	49,430

† Corrected figure not available. * Total imports (Canada and Mexico).

MEXICO

SULPHUR PRODUCTION
(Long tons)

		Azufrera Pan Americana, S.A. de C.V.	Cia. de Azufre Veracruz, S.A.	Central Minera S.A.	Petroleos Mexicanos	Negociacion Minera de Azufre, S.A.	TOTAL
1960							
	January	72,758	21,127	—	7,250	1,500	**112,885***
	February	68,518	17,885	—	7,000	1,500	**105,153†**
	March	71,242	18,740	—	7,312	1,500	**98,794**
	April	58,155	17,710	—	7,235	1,500	**84,600**
	May	64,538	19,236	—	7,600	1,500	**92,874**
	June	77,775	17,659	—	7,665	1,500	**104,589**
	July	94,936	16,555	—	7,500	1,500	**120,491**
	August	103,192	11,417	—	7,200	1,500	**123,309**
	September	96,632	15,388	—	6,900	1,500	**120,420**
	October	110,548	16,800	—	6,480	1,500	**135,328**
	November	107,533	16,377	—	6,219	1,500	**131,629**
	December	101,845	14,390	—	8,310	1,500	**126,045**
1961							
	January	89,347	15,189	2,400	6,370	1,500	**114,806**
	February	80,674	14,150	2,480	5,900	1,500	**104,704**
	March	62,309	18,614	2,500	5,800	1,500	**90,723**
	April	54,201	17,220	2,490	5,650	1,500	**81,060**

* Includes 10,250 tons produced by Exploradora del Istmo.
† " 4,500 " " " " " "

FRANCE

(Metric Tons)

		CRUDE SULPHUR*			**Refined Sulphur	**SULPHURIC ACID PRODUCTION		
		Production	Domestic Sales	Exports	Production	Contact	Chamber	TOTAL
1960								
	March	49,249	18,225	31,533	7,588	93,600	68,600	**162,200**
	April	58,679	23,218	38,870	8,147	96,100	65,500	**161,600**
	May	54,055	24,026	33,553	8,183	96,200	68,800	**165,000**
	June	66,165	24,888	37,277	5,137	98,100	63,200	**161,300**
	July	73,240	23,960	41,331	3,144	101,100	63,800	**164,900**
	August	64,510	15,847	15,237	1,134	89,600	59,700	**149,300**
	September	68,490	28,012	34,612	435	96,200	60,700	**156,900**
	October	73,720	16,794	23,457	2,539	109,900	67,300	**177,200**
	November	82,980	22,809	43,275	5,217	115,000	66,300	**181,300**
	December	88,960	33,519	36,422	6,922	117,200	68,100	**185,300**
1961								
	January	88,174	23,838	42,889	6,690	116,000	64,400	**180,400**
	February	78,350	32,621	28,981	6,888	105,200	59,200	**164,400**
	March	86,949	28,275	53,761	7,978	117,600	61,200	**178,800**
	April	85,698	29,389	46,689	n.a.	117,800p	63,000p	**180,800p**

* Figures reported by So. Nationale des Petroles d'Aquitaine. n.a. not available. p provisional
** Official figures.

CANADA

SULPHUR PRODUCTION

(Short Tons)

	Alberta								TOTAL			British Columbia		
	Jumping Pound	Nevis	Okotoks	Pincher Creek	Red Water	Turner Valley	Homeglen Rimbey	Innisfail	Production	Stocks*	Sales†	Production	Sales	
1960														
Jan.	3,202	2,174	12,319	17,679	218	966	—	—	36,558	209,972¶	10,918	5,420	3,196	76,94
Feb.	2,951	5,099	11,413	16,843	152	861	—	—	37,319	234,115¶	11,667	5,007	3,328	
Mar.	2,931	2,822	11,925	14,356	159	509	—	—	32,702	251,952¶	14,460	5,194	2,792	
Apr.	2,631	2,704	11,435	16,399	87	755	—	—	34,011	269,945¶	15,401	5,162	3,650	82,55
May	2,363¶	2,784	11,934	12,444¶	164¶	718¶	—	—	30,407¶	275,999¶	24,282¶	5,262	3,312	84,50
June	2,044¶	2,399¶	11,969¶	10,016¶	131¶	483¶	—	—	27,042¶	272,969	30,040¶	4,803	2,566	86,73
July	2,017	2,475	4,543	10,326	56	774	—	—	20,191	267,282	25,881	4,597	2,652	
Aug.	2,313	1,540	7,658	7,279	89	751	—	—	19,630	265,387	21,598	4,823	2,906	
Sept.	2,475	1,382	11,478	9,951	142	810	—	—	26,238	270,979	20,398	4,937	3,377	92,49
Oct.	2,876	4,079	11,842	20,776	100	897	—	—	40,570	293,649	16,686	4,699	2,834	94,35
Nov.	3,086	4,041	12,259	17,433	105	882	—	936	38,746§	306,563	25,485	5,090	4,379	95,07
Dec.	3,609	5,027	12,752	21,767	136	730	—	2,298	46,319	336,268	16,496	5,470	2,738	
1961														
Jan.	3,112	4,331	11,387	18,169	154	817	166	2,696	40,832	355,897	18,236	5,685	4,742	98,74
Feb.	2,690	3,343	10,256	14,123	158	736	2,908	2,460	36,674	374,869	17,462	5,295	5,413	98,62

† For 1960 sales in Alberta only. For 1961 local and export sales included. § Includes 4 tons produced at Sedalia. ¶ Revised figures.

* Stocks at end of period shown. This figure is not merely the accumulations of differences between production and sales, as small tonnages of sulphur are co sumed internally and there are also minor monthly adjustments.

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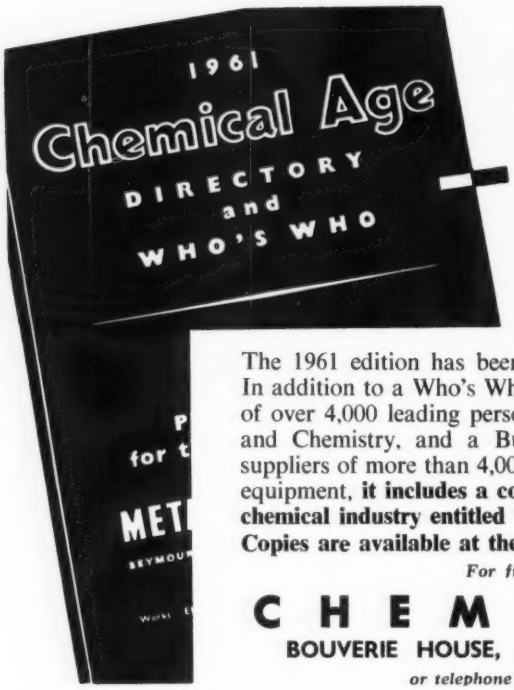

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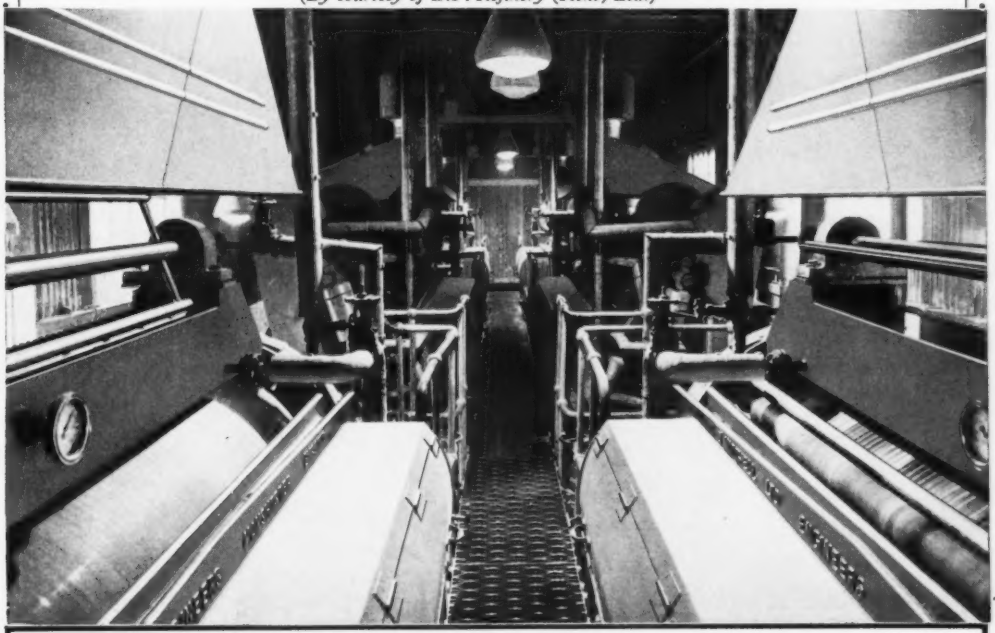

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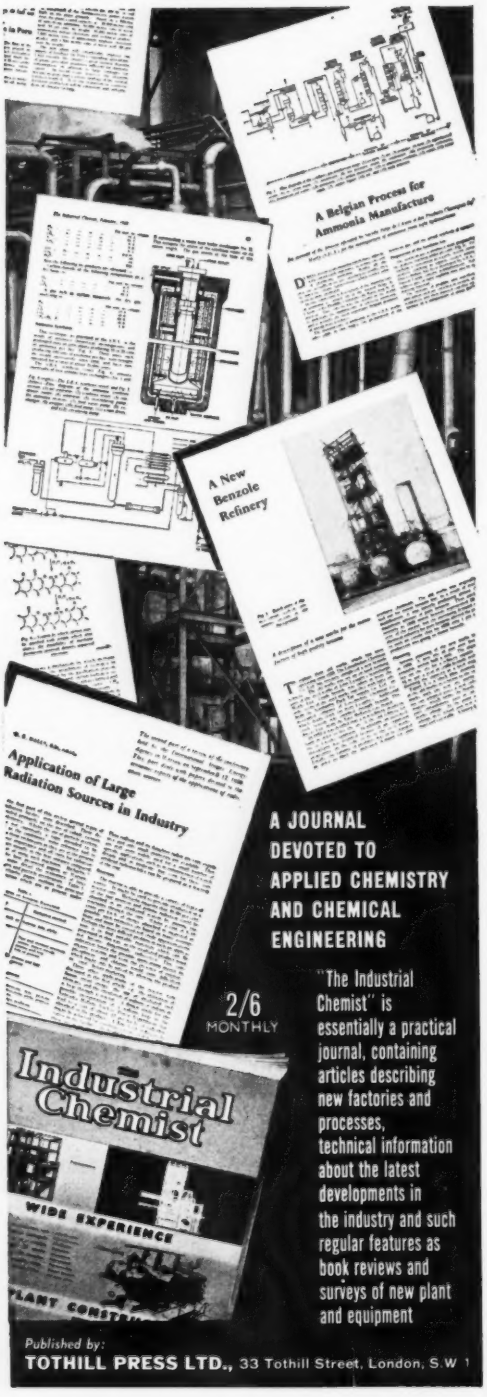
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